

YOUR BUDGET VR RIG

YOU DON'T HAVE TO SPEND THOUSANDS: COMPLETE VR PC BUILDER'S GUIDE INSIDE!

Oct 2016
Issue 433

YOUR EXPERT

GUIDE TO THE BEST VR TECH

**VR-READY GPUS
THAT WON'T
BREAK THE BANK**

AFFORDABLE CARDS FROM AMD & NVIDIA FACE OFF IN THE LABS!



VIRTUAL REVOLUTION HANDBOOK

**INSIDE: EVERYTHING YOU NEED TO KNOW
TO MASTER VR ON YOUR PC**



HEAPS OF EXPERT TECH KNOW-HOW

- CODE YOUR OWN ANDROID APPS
- CONSTRUCT A DIGITAL COMPASS USING AN ARDUINO BOARD
- SEND ENCRYPTED EMAILS IN APPLE MAIL

BEST VR GAMES + SMARTPHONE VR GUIDE

CAN'T AFFORD A HEADSET FOR YOUR PC? NO WORRIES! GET STARTED WITH VR ON YOUR SMARTPHONE NOW FOR NEXT TO NIX!

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- LATEST PC KEYBOARDS, HEADSETS, CASES, PERIPHERALS & MORE
- AMD RADEON RX 460: BEST BUDGET GRAPHICS CARD EVER?



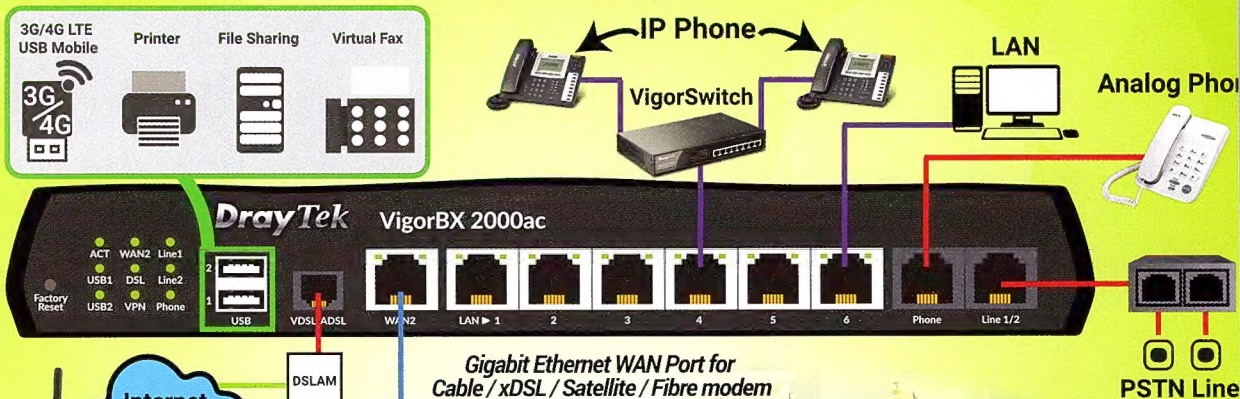
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VigorBX 2000ac



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- Voicemail
- Configurable user prompts
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- Speed Dial
- Virtual FAX

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Future Publishing Australia,
PO Box 1077, Mount Street, North Sydney, NSW 2059
Tel: 02 9955 2677 Fax: 02 9955 2688
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Email: apcmag@futurenet.com
Web: www.apcmag.com

EDITORIAL

Editor-in-Chief Dan Gardiner
Sub-Editor / Journalist Carmel Sealey
Senior Journalist Paul Taylor
Senior Journalist Shaun Prescott
Journalist Joel Burgess
Journalist Stephen Lambrechts

ART/PRODUCTION

Creative Director Troy Coleman
Senior Designer Nykke Coleman
Designer Sharnée Brisbane

CONTRIBUTORS

Desire Athow, JR Bookwalter, Helen Bradley,
George Cairns, James Davenport, Cat Ellis, Craig Grannell,
Lindsay Handmer, Andy Kelly, Jeremy Laird, Gary Marshall,
Nick Peers, Les Pounder, Bennett Ring, Chris Scullion,
Dave Stevenson, Zak Storey, Alexander Tolstoy,
Drew Turney, Luis Villazon, Tyler Wilde, Darren Yates

SENIOR MANAGEMENT

Managing Director APAC Neville Daniels

COMMERCIAL

Sales Director Paul Marttila
paul.marttila@futurenet.com

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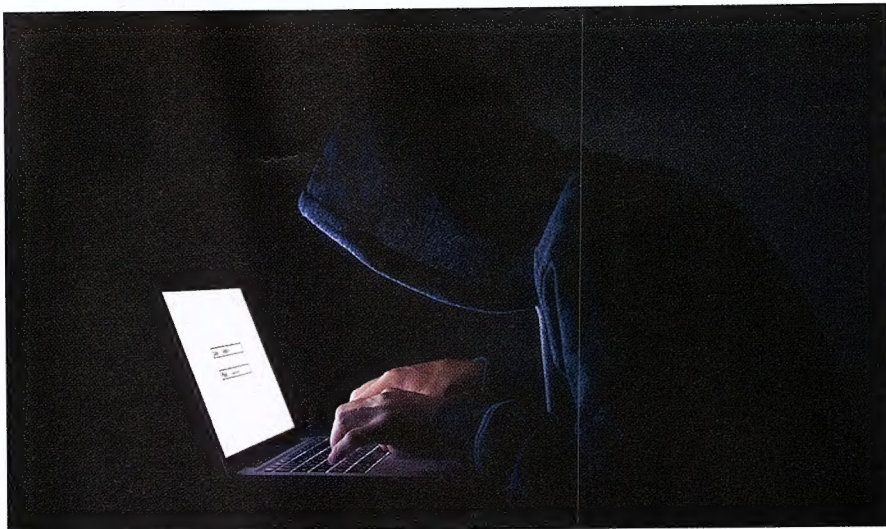
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FIPP



We need a debate about government hacking

APC's editor Dan Gardiner asks whether we need to draw a clear line between cyber offence and defence.

The recent leak of what appears to be an NSA hacking toolkit by a group calling themselves the Shadow Brokers should force us to ask some important questions – specifically, about how Western governments go about hacking and conducting cyberwarfare.

The kit appears to be at least three years old and, so far, only 300MB of it has been released – the Shadow Brokers, say they have more that they're willing to sell to the highest bidder. Even with the relatively limited scope of what's been revealed, though, the tech industry is still reeling from the ramifications.

Increasingly, the toolkit does appear to be legitimate too. Infamous whistleblower Edward Snowden certainly thinks so, and even posits that a Russian agency might be behind it – a warning to the US Government not to attempt to retaliate for recent leaks of Democratic National Committee and Hillary Clinton emails.

Now, I don't think anyone would argue that Western governments shouldn't be allowed to wage cyberwarfare against criminals and terrorist organisations. And this isn't really a question about whether we should allow our governments to hack other sovereign states, either – that genie is, in some sense, already out of the bottle, and when our 'enemies' have dedicated cyberwarfare outfits, it's hard to argue against having our own. What is perhaps worth arguing over

is where we draw the line between having the exploits to do the job and responsibly disclosing those exploits to make the entire internet safer. Despite assurances just a few months ago that it didn't hoard security flaws and disclosed as many as possible so they can be patched, it does seem the NSA has been sitting on dozens of exploits – the fact that the leaked toolkit is three years old and still has unknown flaws would seem to clearly demonstrate that.

Those 'zero day' flaws are a potential danger to individuals and companies – but also to our own governments. With the leak of this toolkit, our enemies have the ability to use those very same exploits – and even the NSA's own custom-made hacking tools – against us, for however long it takes corporations to fix them all. That's a process that security experts and analysts have admitted could take months.

So when does the danger start to outweigh the benefit? There needs to be clear guidelines about how long our security agencies are allowed to hold on to exploits before having to disclose them – a trade off, yes, but one that will hopefully keep us all safer. ■



DAN GARDINER
EDITOR-IN-CHIEF
dan.gardiner@futurenet.com

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VIRTUAL REVOLUTION HANDBOOK

EVERYTHING YOU NEED TO KNOW TO GET
STARTED WITH VR ON YOUR PC

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SCI-FI MOVIES AND POP CULTURE
HAVE ALWAYS DEPICTED THE IDEAL
ELECTRONIC COMPANION TO HELP
MANAGE YOUR LIFE, AND YOU MIGHT
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"Hopefully, we don't end up living in liquid cocoons, living as batteries for a highly evolved AI race." Upcoming VR tech, page 68.



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News from the world of geekdom.

TURN THE PAGE FOR YOUR EXCLUSIVE FREE SOFTWARE OFFERS

A box for Ashampoo Slideshow software, featuring a person running on a beach at sunset.

A box for StartupStar software, featuring a rocket ship launching.

exclusive software

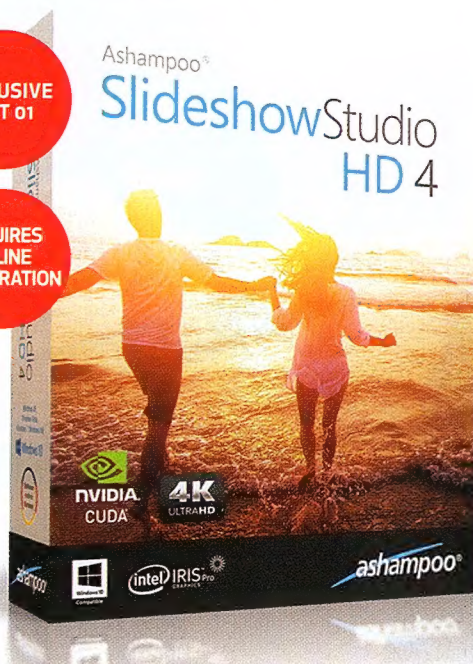
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ISSUE 433, OCTOBER 2016

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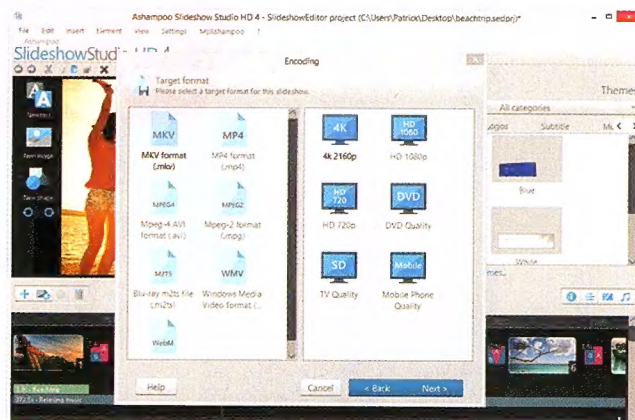
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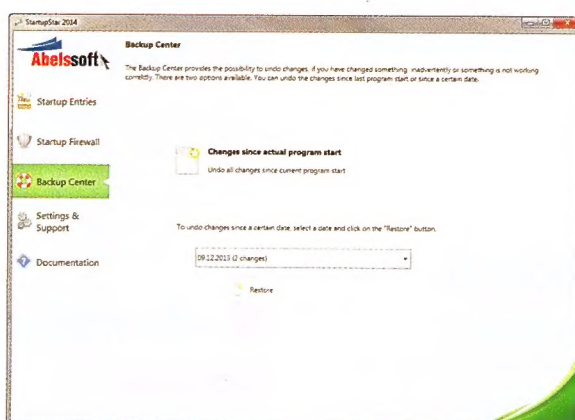
SWAT CUMBERSOME BACKGROUND OPERATIONS

Remove and add start-up applications from Windows with Abelssoft StartupStar.

FULL VERSION WORTH US\$37.

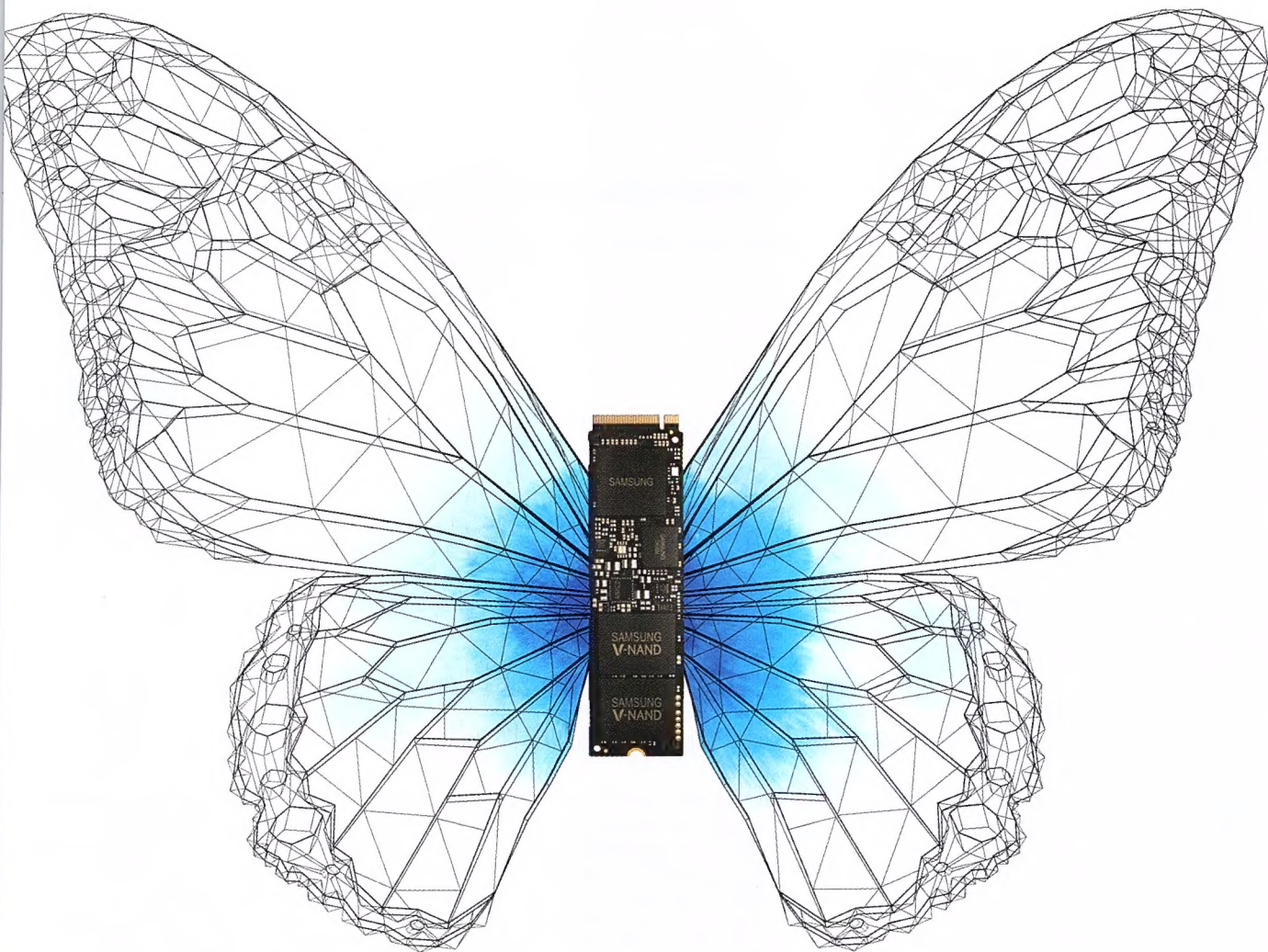
Did you know that an average PC has more than 20 different applications that are launched automatically when you start your PC? A lot of those startup entries are unnecessary and they can slow down your PC's starting time. With StartupStar, you can see a quick and efficient overview of all startup entries and then enable, disable, or delete them as desired.

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*Performance benchmark product : 950 PRO(512GB)



'Smart' Bluetooth locks not actually so safe

INTERNET OF THINGS STILL NOT VERY SECURE.

According to a presentation made at this year's DEF CON hacking conference, we're still a long way from having truly safe smart locks. Anthony Rose and Ben Ramsey of Mercurite Security took to the stage to demonstrate how easily the locks can be compromised using simple hacker tricks — some locks displayed passwords in plaintext, while others were cracked using a Bluetooth sniffer. SL

Gaming good for students' results, Australian study finds

SPENDING TIME ON SOCIAL MEDIA... NOT SO MUCH.

According to new research published on the International Journal of Communication website, teenagers who regularly play online video games tend to perform better at school. Alberto Posso, Associate Professor at RMIT's School of Economics, Finance and Marketing, says that "students who play online games almost every day score 15 points above the average in maths and 17 points above the average in science". Posso explained that "when you play online games, you're solving puzzles to move to the next level and that involves using some of the general knowledge and skills in maths, reading and science that you've been taught during the day". Social media, however, has an adverse effect, with Facebook-obsessed teens scoring 20 points worse on average in maths. Associate Professor Posso says "students who are regularly on social media are, of course, losing time that could be spent on study — but it may also indicate that they are struggling with maths, reading and science and are going online to socialise instead". SL



The census.abs.gov.au page isn't working

census.abs.gov.au didn't send any data.

ERR_EMPTY_RESPONSE

DETAILS

Reload

DDoS not responsible for Census site failure, experts claim

Was it or was it not hacked?

The Australian Bureau of Statistics (ABS) website experienced a colossal meltdown recently when it attempted to allow users to submit their Census forms online for the first time. However, millions of Australians were unable to complete their forms, leading the ABS to claim that overseas DDoS attacks forced them to take the site offline as a precaution.

Now, experts at the University of Wollongong are casting doubt on the Bureau's claims in an article published on university website, The Stand. In the post, titled 'Census fail: counting the cost', Professor Katina Michael said, "Network activity maps on the night of 9 August don't show evidence of an attack from overseas." Professor Willy Susilo, Director of the Centre for Computer and Information Security Research, is in agreement, stating that the ABS "mentioned the possibility of four attacks, but by the time the fourth attack happened, the website would have been closed down to ensure the security of the data. This does not sound like a denial of service attack to me". **Stephen Lambrechts**

Is Facebook gearing up to take on Valve's Steam?

ZUCK & CO. WORKING ON A UNITY-BASED PC GAMING PLATFORM.

Facebook is set to get an "all-new PC gaming platform" powered by a publishing partnership with Unity, the company has announced. Basically, Facebook and Unity are working together to streamline the development process for games published on Facebook's forthcoming platform, meaning exporting and publishing to Facebook from Unity should be easier. "This will allow Unity developers to quickly deliver their games to the more than 650 million players who enjoy playing Facebook-connected games every month," the announcement on Facebook's developer website states. A closed-alpha build is currently available to select studios, but no timeframe for the roll-out of the platform proper was provided. The integration will only work with titles using Unity 5.4 and above. That version launched earlier this year, ushering in "enhanced visuals, better performance, tighter Unity IAP integration and a major VR rendering upgrade", according to the Unity Technologies announcement. The company hasn't indicated whether it intends to sell non-Unity games on its platform. **Stephen Lambrechts**





Facebook blocks ad-blockers

AD-BLOCKERS RESPOND WITH AN IMPERFECT BYPASS.

In an effort to thwart ad-blockers, Facebook recently announced a workaround that would blend the HTML of its ads into its content, making it almost impossible to discern from regular posts. In almost no time, Adblock Plus released its own bypass to Facebook's solution, though according to the social network, it also blocks legitimate posts from friends and pages. **SL**

Hell freezes over: Intel set to make ARM-based processors

HOPES TO OVERTHROW TSMC AND SAMSUNG WITH ITS OWN 10NM CHIPS.

After having dropped its ARM division back in 2006 to focus its attention on x86 processors, Intel has found itself crawling back to the family of RISC architectures after the failure of its x86-based smartphone chips. However, Intel won't be designing and selling its own ARM-based processors, instead opting to produce chips for other companies using its custom foundry business. **SL**

It's official — us Aussies pay more for internet access

TELSTRA AND OPTUS ARE TWO OF THE BIGGEST OFFENDERS.

According to content delivery network CloudFlare, the relative cost of bandwidth units in Australia is 17 times higher than it is in Europe. Most of the blame is laid on the shoulders of Optus and Telstra, stating that they don't reduce the cost of their bandwidth by 'peering' like smaller providers do. The data also revealed Optus as one of the six most expensive ISPs in the world. **SL**



Intel's Project Alloy leaves current AR & VR for dead

Chip-maker shows off untethered 'mixed reality' headset at annual Developer Forum.

Big news was announced out of the 2016 Intel Developer Forum in San Francisco late August, with Intel CEO Brian Krzanich unveiling Project Alloy, an open platform, all-in-one virtual reality solution that takes advantage of Intel's RealSense technology. Unlike the Oculus Rift and HTC Vive, Project Alloy promises a completely untethered VR experience, free from the usual cables that keep competing devices connected to a computer. In the case of this VR unit, all of its computing power is located in what's being referred to as the Alloy Head-Mounted Device. Though the HTC Vive requires sensors to be placed around your play area, Project Alloy uses cameras in its headset to gauge your surroundings — this allows the device's Intel RealSense technology to implement collision detection that keeps you from running into objects around you. On top of that, you'll also be able to see your own hands and other people while wearing the headset. Developers will be able to get their hands on the open API next year.

Stephen Lambrechts

Happy Windows anniversary!

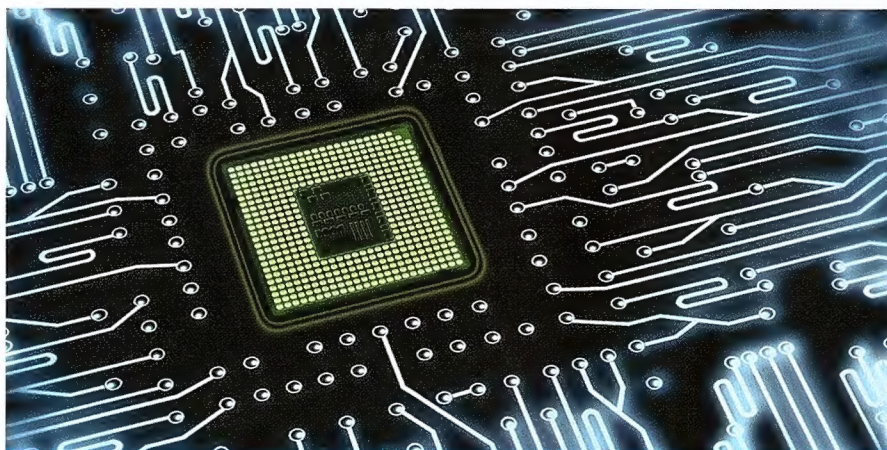
LET'S CELEBRATE WITH BORKED WEBCAMS AND XBOX ONE CONTROLLERS.

Though Microsoft's Windows 10 Anniversary Update came with a number of useful fixes, including new Cortana features and virtual desktop pins, users are reporting that it's also introduced a heap of problems. Among these are system-wide freezing issues, Xbox One controllers that can't be recognised, and a codec issue that's caused millions of webcams to completely stop working. Microsoft insists that fixes are coming soon. **SL**



technotes

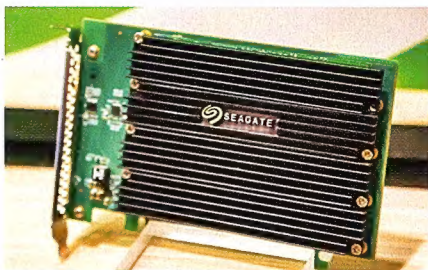
» CARMEL SEALEY LOOKS AT THE NUMBERS DRIVING THE NEWS.



2021

THE YEAR IN WHICH TRANSISTORS WILL STOP SHRINKING, ACCORDING TO A NEW ASSESSMENT OF MOORE'S LAW.

Some things can only get so small and the run of the shrinking transistor could almost be over. According to Moore's Law — a theory that dictates that the number of transistors in a chip would double every two years — beyond 2021, it will no longer be economically advisable for chip manufacturers to shrink chips further. While the miniaturisation of transistors once translated to faster speeds, that is no longer necessarily the case, as companies now look to stack in 3D formations. So is this the end of Moore's Law being used in roadmapping? Only time will tell.



60TB

THE SIZE OF THE WORLD'S LARGEST SSD, WHICH COSTS US\$10,000.

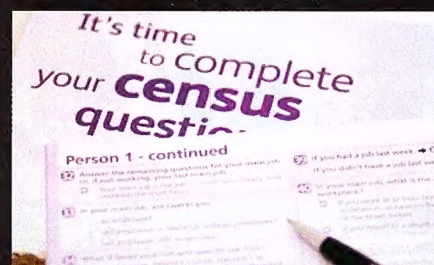
The Seagate 60TB SSD (which uses Micron-sourced 384-gigabit chips in a 3.5-inch form factor) takes the gold for the highest capacity SSD in the world (at the moment). While the release date of this model is a bit up in the air, the asking price is expected to be just shy of US\$10,000. However, Samsung's also claiming to have built the largest SSD — using a different metric — with its 2.5-inch 32TB model, which uses its own 512-gigabit chips. While it's lower capacity, its data density is more impressive.



350m

THE NUMBER OF DEVICES THAT NOW HAVE WINDOWS 10.

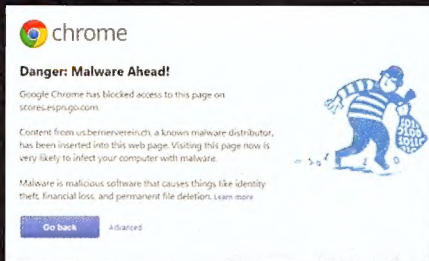
On the 29th of July, Microsoft ended its 12-month free upgrade period to Windows 10 for users running Windows 7 and 8.1. While some missed the boat, 350 million devices had made the transition (or were bought new with Windows 10 already installed) within the first year — a pretty good start. Microsoft is aiming to make that number one billion within the next two or three years, but with PC sales currently slumped, this might be a fairly optimistic goal.



\$9.6m

THE AMOUNT SPENT ON THE FAILED CENSUS WEBSITE.

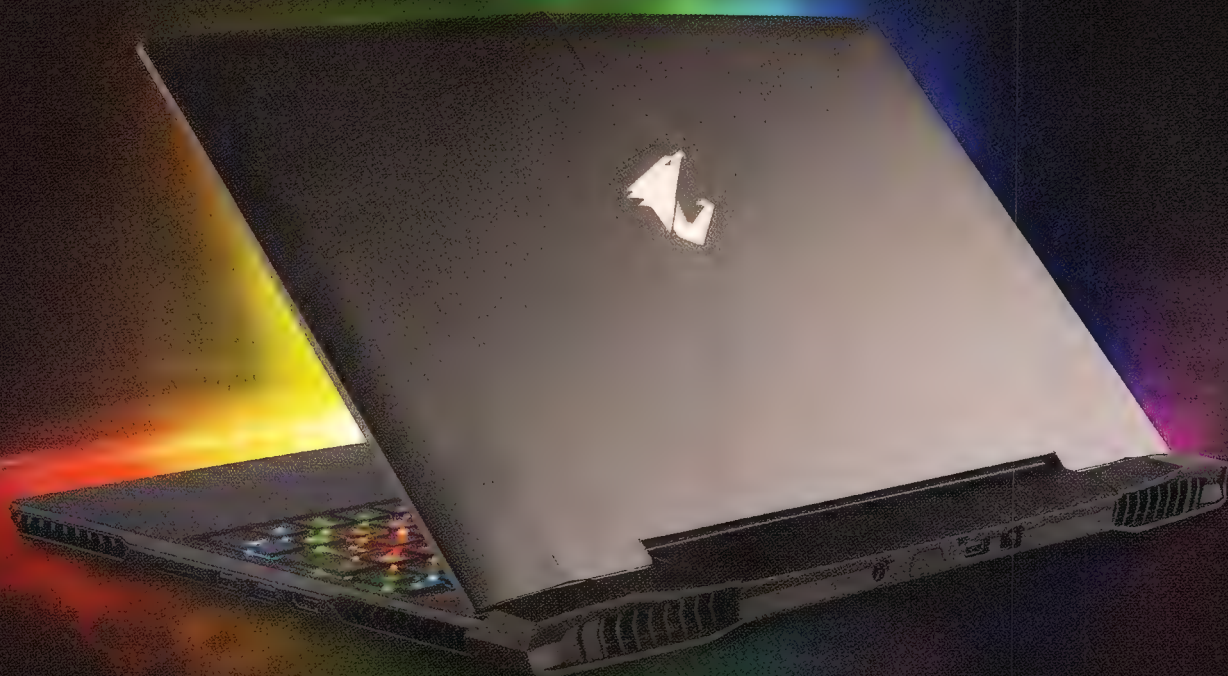
The Australian Government blames the failure of its first online Census on a distributed denial of service (DDoS) attack, while others believe that this is merely an excuse used by authorities to cover up embarrassing technical failures. Regardless of the cause of the outage — which saw millions of Australians unable to take part in the Census on the 9th of August — many are asking how a \$9.6 million contract could have amounted to such a failure.



90%

HOW OFTEN WE IGNORE SECURITY PROMPTS ON OUR DIGITAL DEVICES.

According to a study from Brigham Young University, despite the fact that we seem more concerned about our privacy and the security of our devices, we ignore security warnings up to 90% of the time. The study focuses on how dual-task interference (such as closing a security pop-up) can impact on the primary task being performed (such as browsing the web), but also notes that ignoring such alerts can leave the user vulnerable, as well as slightly distracted.



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Engine



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Broadcaster Streaming
Software



Killer DoubleShot Pro:
Optimized Gaming
Network

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www.aorus.com

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technotes

» GEAR WE WANT

THE SUPERBOOK

US\$99 | GETSUPERBOOK.COM

It was recently reported worldwide that more Chromebooks were sold in the first quarter of of this year than Apple sold across it's entire computing range, so we weren't particularly surprised when this Kickstarter stirred a hefty response. That said, no one could have perhaps imagined that a clamshell laptop designed to be powered by your existing Android phone would rake in close to US\$3 million (6,000% of its initial US\$50,000 funding goal). Most Android smartphones these days are more than capable of running Chrome OS, so for US\$99, it is an excellent solution that could save some users from having to buy a much more expensive standalone laptop. JB



SONY DUALSHOCK 4 WIRELESS USB ADAPTOR

US\$25 | PC, MAC | WWW.SONY.COM.AU

In an impromptu announcement on the official PlayStation Blog in August, Sony revealed that it will be releasing an official DualShock 4 Wireless dongle that'll allow you to use your PS4 controllers with a Mac or PC. The Wireless Adaptors will be available in Australia, Europe and the US from September 16th. The announcement came in conjunction with the addition of a number of PS4 titles on the PlayStation Now game streaming service, which is still yet to launch locally. JB



KOBO AURA ONE

\$350 | KOBO.COM

Kobo might still seem like the ugly alternative to Amazon's Kindle devices to some, but the e-reader maker has actually come into it's own in recent years, creating a number of models that are arguably better than Amazon's offerings, depending on your needs. The Kobo Aura One looks like it'll be another win, as the main selling points reportedly stem from the most wanted features, requested in user feedback. With a larger, hardcover-sized 7.8-inch screen featuring print-quality 300ppi resolution, an automatic 'red shift' night-time reading mode that won't disrupt your sleep (as much), library e-book borrowing compatibility and all the features we already expect from a quality e-reader, this is definitely a device we're keen to get our mitts on. JB





LG ROLLING BOT

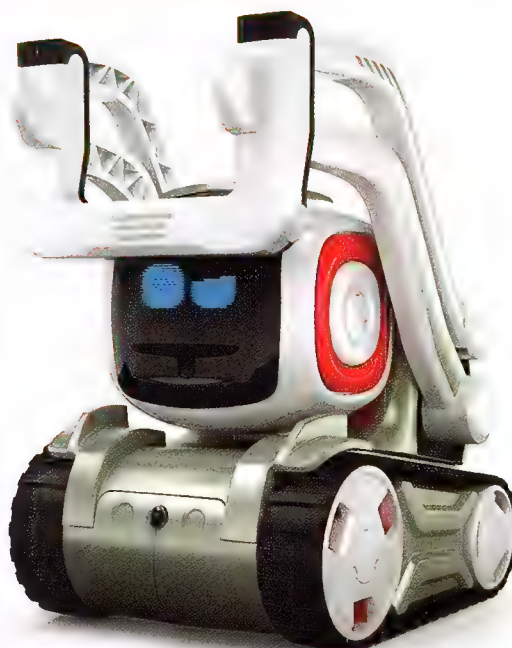
US\$247 | LG.COM

It's not quite BB-8, but LG's new home monitoring system certainly has the same kind of vibe. As its name implies, this little fella rolls about your home while constantly recording video and audio, which can be viewed from your iPhone or iPad – or you can use the accompanying app to remotely control it yourself. It's got Bluetooth and Wi-Fi, so can interact with other smart home gadgets you have, plus a mic and speaker. When it gets low on charge, it'll automatically locate its dock and roll on up to get juiced. Most gloriously of all, there's a built-in laser pointer which you can use to amuse/terrify your pets remotely.

ANKI COZMO

US\$180 | ANKI.COM

We're gearing ourselves up for a future with bots, so now is a good time to meet Cozmo – because he's both clever and cute. This tiny little robot (who might be from a future series of *Bob the Builder*...) is apparently "addicted to fun" and he's been programmed (well, his app has, anyway) to respond to your involvement. Ignore him and he'll pester you – or even sulk. Play with him and he'll adapt to your preferences, and reward you with new activities and upgrades. There are a number of games to play, and thanks to Cozmo's gamut of facial expressions to convey emotions, you may find yourself forming a real bond...



STARRY

US\$349 | STARRY.COM

Say goodbye to staring at the non-communicative blinking lights on your router, because Starry is a router that makes everything you need to know clear and simple, and a lot more user-friendly. You can check how your Wi-Fi is performing with displays for rating speed and connected devices. If there's a problem with a device, the information will flash up in red, and you simply tap on it to find out what the issue is, and you get tips on how to resolve the problem. You can request help from the Starry team directly from the unit itself (this free "support on demand" service runs for 12 months). But our favourite feature is the ability to customise the Wi-Fi name and password and display it on screen, so it's easy to recognise and remember. You can even get the app to text name and password details to any guests. The app also enables you to set up parental controls with separate preferences for different devices. ■



tech

INSIDE APC

DIY BUDGET VR RIG (YOU DON'T HAVE TO SPEND THOUSANDS: COMPLETE VR BUILDERS' GUIDE INSIDE)

apc Oct 2016 Issue #35
YOUR EXPERT

VR-READY GPUs THAT WON'T BREAK THE BANK
AFFORDABLE CARDS FROM \$100 & NVIDIA FACE OFF IN THE LABS

VIRTUAL REVOLUTION HANDBOOK

INSIDE: EVERYTHING YOU NEED TO KNOW TO MASTER VR ON YOUR PC

HEAPS OF EXPERT TECH KNOW-HOW

- CPU: Intel Core i7-6700K
- GPU: NVIDIA GeForce GTX 980
- RAM: 16GB DDR4
- SSD: 128GB
- PSU: 750W
- CASE: Fractal Design Define R4

BEST VR GAMES + SMARTPHONE VR GUIDE

- VR Games: Beat Saber, Superhot
- Smartphone VR: Google Cardboard, Samsung Gear VR

HOTTEST NEW PCs & TECH REVIEWED

- ASUS ROG Strix GL502
- MSI GS63VR
- Alienware 17
- Razer Blade Pro

20 www.apcmag.com

the **apc** **RECOMMENDS**

One of the best laptops of this system is that it is the only one that can fit a 13.3 inch form factor.

Fujitsu LifeBook E736
Could this be the perfect mobile workstation?

FROM \$1,400 (CORE I5 MODEL) WWW.FUJITSU.COM/AU

The display is attached to the base via hinges. We noticed that for the display, the software associated with the laptop. The keyboard is the same as the laptop. The keyboard is the same as the laptop. The keyboard is the same as the laptop.

Fujitsu's design suggests keeping things as simple as possible. The CPU speed will drop in a way as to prevent too much heat from being generated. As expected, battery life was a bit of a letdown. At 12 hours, playing an MKV file with no sound and brightness set at 50%.

But the LifeBook E736 won't appeal to everyone. Its price and design drawbacks on the face of some of its consumer-oriented colleagues. But this laptop is more suited to business users. It does a few things well when it comes to modularity, expandability, performance, manageability and battery life. The particular model we tested has a 13.3 inch display, 16GB of memory, a 1TB HDD and a 128GB SSD. Regardless of the configuration, it's a 13.3 inch laptop, so it's a bit of a compromise. It's a bit of a compromise. It's a bit of a compromise.

Verdict
★★★★
Features ★★★★★
Performance ★★★★★
Value ★★★★★

Agreed business laptop, shop around for Fujitsu's E736 for under \$1,000 to get the best bang for your buck.

Antec's Signature Series S10
Sony MDR-CL1

Inside APC

Find out all about APC's editorial policies, test practices, how to read the benchmark results and more.

APC is Australia's oldest consumer technology magazine – having been consistently in print for over 35 years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer – it's in our name, after all – the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech too, from smartphones and apps to peripherals, accessories, online services and beyond. We have two main goals: to track down the best of modern tech and also to help our readers make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And like you, APC's journalists want to know what's good in tech – no matter what platform it resides on.

INDEPENDENT REVIEWS

Championing technology doesn't mean we're unrelenting yes-men, however, and APC aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three.

As a matter of policy, reviews published in APC are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an APC reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

LABS TESTING

Despite being a small magazine with limited resources, APC still strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance, gaming and battery life.

In most cases, for the benchmark results published in APC, you can assume that higher is better. There are certain tests that deviate from this rule and where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter are our preference due to their ease-of-readability, but tables are more compact, so we use these in cases where thoroughness is preferred.



HTC Vive

What does tearing apart Valve's VR headset reveal?

BACKGROUND:

Around here, it's all about gadget guts. With VR becoming all the rage, we couldn't wait for a Vive-section. What does HTC have hiding before your eyes? Strap a black box to your head, 'cause we're about to find out! It's time to tear down the Vive.

MAJOR TECH SPECS:

- 2x 1080p AMOLED displays – 2,160 x 1,200 combined resolution
- 90Hz refresh rate
- Built-in front-facing camera and microphone
- Accelerometer, gyroscope and laser position sensor
- 360-degree headset tracking via Lighthouse IR emitters
- 110-degree horizontal field of view

KEY FINDINGS:

- After unplugging the four headset cables, we spot a standard 3.5mm audio jack, a DC barrel jack and a single HDMI port, flanked by two USB 3.0 ports. Interestingly, HTC left the right-most USB port open for third-party accessories.
- Nestled between the eyepieces is a proximity sensor, which detects when the Vive is on your face – for power-saving reasons. Cog-zooks!



We've got our gears turning as we remove the eye-relief adjustment on the Vive headset; not to be confused with IPD, this controls the distance from the headset's optics to your eyes.

- Pulling back the outer shell on the Vive reveals a number of sensors – 32 in total, according to HTC. These photodiodes take in IR light from the two Lighthouse base stations as they flash and sweep light across the room. This enables a connected PC to calculate the headset's position and orientation in space, as a function of the time between receiving the flash and the following IR laser sweep – the opposite of the head-tracking technique of the Oculus Rift.
- After removing four Phillips screws, we lift away the display cover for access to one of the twin Samsung AMOLED panels. Each display measures -91.8 mm diagonally, which translates to -447ppi. For comparison,

the Rift CV1 has -456ppi, due to a slightly smaller display (90mm) that still packs the same resolution as the Vive. A bit of adhesive secures each lens, but it doesn't take much to pop them out.

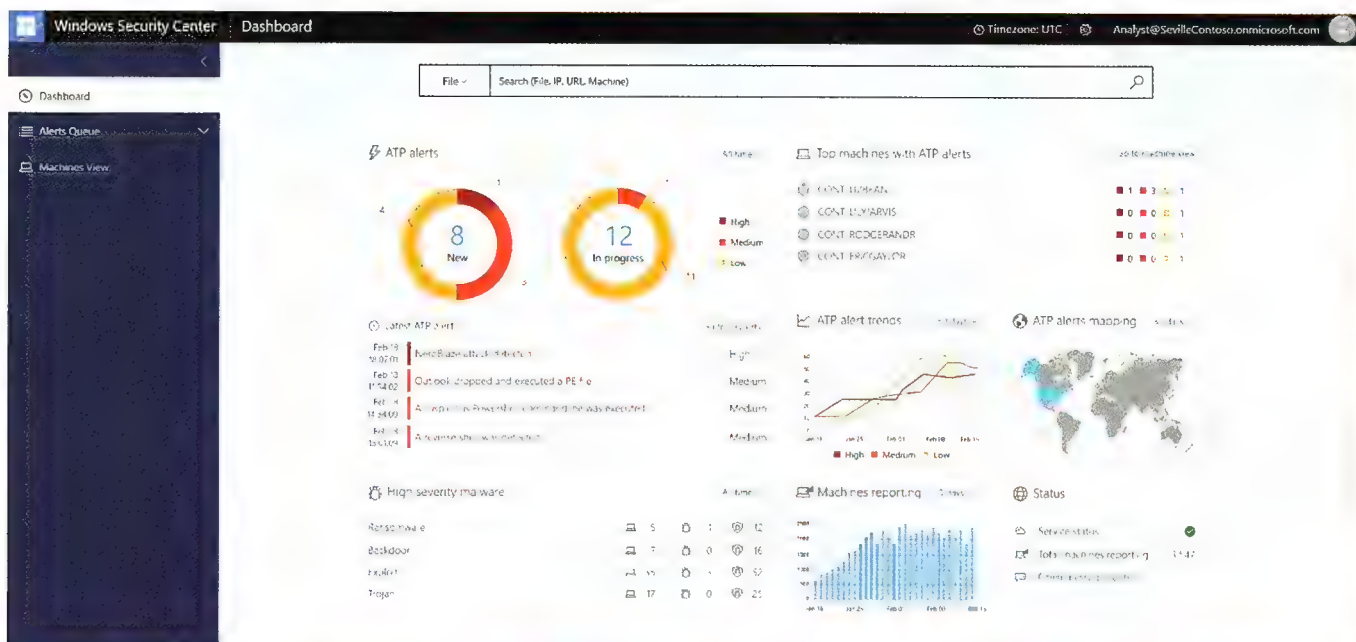
- Repairability Score: 8 out of 10 (10 is easiest). Although it's a complicated bit of gear, the headset breaks down without damage. The head strap and face pads are removable, and don't incorporate sensors or electronics that might be prone to failure. Phillips and Torx screws are used throughout. Reuse of the touchpad hardware from the Steam Controller means some replacement parts are likely already available. The large number of components, many quite delicate, means you'll want a service manual before attempting repairs. Adhesive is used sparingly, but secures the lenses, Lighthouse base station covers, and sensor arrays. ■

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.

technotes

» EPINIONS



WINDOWS 10 STILL NEEDS WORK

Although Windows 10 may have recently turned one, it seems to have a bad case of aging without growing more mature. The Windows Store hasn't left the ground, Settings and Control Panel still frustratingly coexist and Cortana is not intelligent enough to be practical to use.

Sure, a nicer-looking lock screen, a few other UI changes and the Windows subsystem for Linux are nice, but as far as changing the experience of the average user goes, they're hardly ground-breaking.

Windows 10 isn't bad – it's certainly better than Windows 8 and 8.1. Windows 8 was so divided between the classic desktop and the new Metro interface it was like trying to make sense of split personalities.

So far, the Universal Windows 10 Platform is something of a train wreck, though; but much like being in a train that veers off the rails and crashes, it is difficult to escape from.

In fact, the only reason I haven't abandoned Windows 10 entirely for Linux is because Ubuntu isn't stable enough running on my laptop.

David V

"Sure, a nicer-looking lock screen, a few other UI changes and the Windows subsystem for Linux are nice, but as far as changing the experience of the average user goes, they're hardly ground-breaking."

TELL ME LINUX IS GREAT (PLEASE!)

As suggested in the last issue, I am writing in the hope that you can de-mystify Linux. I have installed various flavours on my various laptops and PCs and I am surprised with how well it functions on even the most basic of equipment.

Revelling in its availability, I have tried maybe five different distributions, but for some inexplicable reason, I have always gone back to Windows. Be it familiarity or just that I am comfortable in a Windows environment, there always seemed

something alien or uncomfortable about Linux despite its functionality. Even with Wine – where I could use Windows programs in Linux – it just seemed a bit strange.

In a nutshell, I need someone to talk me into this... I know it's freely available but are there any real advantages? Is there anything extra I should be aware of? I truly want to like Linux but something is telling me there is an issue somewhere. Tell me I'm wrong.

Timothy Whitworth ■

APCMAG@FUTURENET.COM

Come on, have your say!

We want to hear what you think. Add to these discussions or email your views (in fewer than 250 words) to apcmag@futurenet.com. All correspondence becomes the property of APC and is subject to editing. Letters must include full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.

Consumer protection network comes down on rogue bloggers

Disclosure and conflict-of-interest under Shaun Prescott's microscope.

Traditional media hasn't had a great run of it this century: not only has the internet bitten crater-sized chunks from the industry, but a new breed of rogue 'influencers' are muddying the formerly unambiguous notion of journalistic ethics. Whereas journalists have typically been beholden to the standards set by major mastheads ("typically" not "invariably"), the age of the blogger has ushered in a new generation which either doesn't know much or simply doesn't care about concepts such as conflict-of-interest or disclosure.

The blogging revolution hasn't been all bad: it was important for the way it democratised the creation and dissemination of news, and it has doubtless taught consumers lessons about what the major outlets will and will not report. While its benefits have been manifold in current affairs reporting, the consumer-oriented press is flooded with advertisers masquerading as impartial critics, particularly on YouTube. This has resulted in major YouTube personalities not disclosing payments

made by companies to showcase their products, and in a recent case, celebrities showcasing gambling websites without disclosing that they do, in fact, own the gambling website.

While a lot of this could be blamed on naivety — many 'influencers' may not have proper media training, for whatever that's worth nowadays — it's nonetheless a growing concern.

In July, the International Consumer Protection and Enforcement Network published a set of guidelines intended for online reviews and endorsements, designed for review administrators, traders and marketers, and digital influencers. The main thrust of it is as follows: if you're in a position of influence, then you should be obligated to tell 'readers/viewers about any incentive (financial or otherwise) that may have influenced or led them to post particular content'.

There's tons of examples of this not being done. Earlier this year, Warner Bros. settled an FTC complaint which accused the video game publisher of spending tens of thousands of dollars for positive YouTube reviews of *Middle Earth: Shadow of Mordor*. While the material would have been acceptable

if flagged as sponsored content, in many cases, it was not, or when it was, it was not immediately visible.

Meanwhile, two Twitch streamers who showcased the *Counter-Strike: Global Offensive* gambling website CSGO Lotto were later found to have actually owned the website.

It's probably fair to say that the vast number of popular YouTubers or 'influencers' do not receive undisclosed payments and/or incentives from companies — to tar everyone with the same brush is unhelpful. What it does demonstrate is that when the media is 'democratised' — when it's easy enough for anyone to get in front of a streaming cam and become an authority — then a wider understanding of media ethics is crucial. And if the ethics are understood and then flagrantly ignored, then there probably needs to be some form of disciplinary hammer forged in order to maintain some semblance of trust in the media as a whole. In our post-Wikileaks age, we might not have too much hope for that anyway, but knowing that 8/10 score for the latest *Mortal Kombat* game wasn't paid for would be nice enough. ■

ENDUSER

Share your stories!

If you have an interesting story about technology users, their experiences and the issues that affect us all (whether funny or serious), email us at apcmag@futurenet.com. All correspondence becomes the property of APC and is subject to editing. Letters must include writer's full name, street address, suburb, state and phone number to be considered for print publication. Address and phone details will not be published.



BULLETPROOF POWER

IF YOUR PC CAN'T AFFORD ANY DOWNTIME, FSP's TWINS-SERIES PSUs PROVIDE A ROBUST AND FULLY-REDUNDANT POWER SOLUTION.

One of the unavoidable facts of life is that, sooner or later, a computer power supply will go belly up. Of course, it tends to happen at the most inconvenient time, but overall it's not usually a big deal. Unless, of course, you're running a home or small business server, you use your PC for mission-critical work, or you just want the most reliable system possible.

The boffins over at FSP have solved the problem with the Twins Series — a totally redundant dual PSU that slots straight into a normal ATX PS/2 chassis. Unlike some other redundant supplies, no extra brackets, cabling or a custom install is needed, and it's affordable enough for high-end home use. The Twins Series also has a range of extra features that will appeal to those who want to build the very best system. The new PSUs will be available in Australia from October 2016.

HOW IT WORKS

The Twins Series comes in two different models, rated at 500W and 700W. Both use the PS/2 form factor, but round the back, there are dual mains plug inputs. On the business end, the Twins Series has the normal array of motherboard and power connectors, so installation is the same as any other PSU. Inside the unit are two individual, and separate, PSU modules, which can each handle the full load if one ever conks out. They also both have a 40mm server-grade dual ball-bearing fan. Of course, the FSP Twins Series modules are

unlikely to fail and are rated at 100,000 hours MTBF, with a 5-year warranty, but the peace of mind is well worth it.

HOT SWAPPABLE

To ensure zero downtime, the PSU modules can be hot swapped with no interruptions. Normally, both modules share the full load of running the PC, for optimum efficiency. In the event that one fails, the other seamlessly takes over. The problem module can then be unclipped and removed from the rear of the PSU without any tools. When a working module is replaced, the PSU goes back to sharing the load. The dual nature also means that, by using an extension cable or UPS, the PC can be physically moved to a different location without needing to be powered down.

PSU MANAGEMENT

While many power supplies are just inscrutable boxes from the outside, the Twins Series has a comprehensive monitoring and control system. Connecting via USB, the FSP Guardian software provides a wealth of historical and real-time data: It can monitor power input and output, efficiency, temperature, fan speeds, operational hours, calculate running cost and more for each module. If there is an issue, the software will also provide a warning to the user.

IMPORTANT FEATURES

The Twins Series doesn't cut any corners to squeeze the redundant supplies into the one

PSU SPECS

Power: 500W / 700W
Size: ATX PS/2 Redundant
Efficiency: 90%
Fan: 2 x 40mm dual ball bearing
MTBF: 100,000 hours
Warranty: 5 years
Weight: 2.85kg
Dimensions: 1,500 x 860 x 1,900mm

PSU CABLES

1 x 24-pin
2 x 4+4 pin
2 x 6+2 pin
6 x SATA
2 x Molex
1 x Floppy

FSP RETAIL PRODUCT WEBSITE:

www.FSPLifeStyle.com

FSP BLOG

blog.fsp-group.com

FACEBOOK

www.facebook.com/FSP.global

LINKEDIN

www.linkedin.com/company/1842554



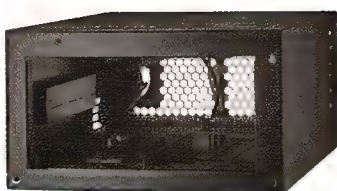
With dual redundant PSU units, the Twins Series provides uninterrupted operation.



Each PSU module can be simply unclipped and removed with no special tools



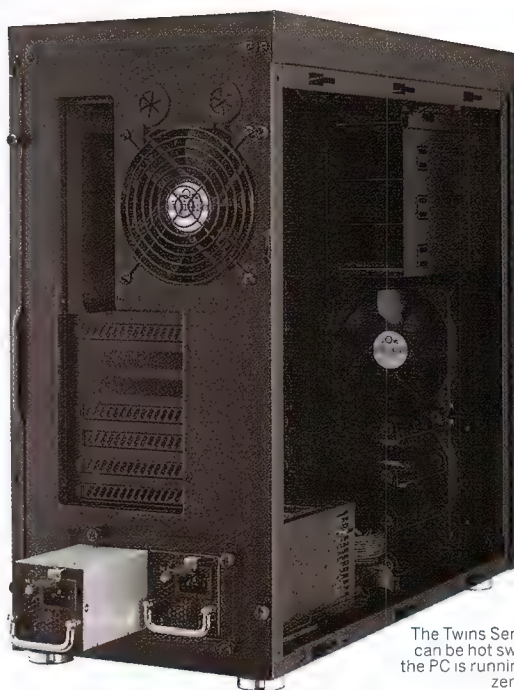
Each Twins Series module is rated for the entire PC load, and can be monitored via the included software.



The outer PSU shell uses the standard PS/2 form factor and works as a direct replacement for an existing power supply.



Round the business end, the power supply has the usual array of connectors, and uses flat ribbon cables for simpler routing.



The Twins Series modules can be hot swapped while the PC is running, to ensure zero downtime.

unit. It has an 80 Plus 230V Internal Gold Certification, for excellent efficiency and active PFC. The PSU also has built-in overcurrent protection, short circuit protection, and monitors for fan failures. Aside from the FSP Guardian software, the Twins Series also has an LED indicator to show the status of the modules.

CONNECTIONS

The Twins Series has all the same plugs you would expect for an ATX PS/2 PSU, so can be used in anything from a workstation, to a home server or gaming PC. It uses

flat ribbon cables, which are ideal for cable management and routing in tight spaces. Both the 700W and 500W models have the same array of power connectors. These include a 24-pin motherboard plug (500mm long) and two 4+4 pin connectors (600mm long). For GPUs, there are two more 6+2 pin connectors (450 + 150mm long). For SSDs and other power needs, it has 6 SATA connections, 2 Molex, and even supports the older floppy plug, which can be handy for legacy compatibility. It also has a USB plug, for FSP Guardian software monitoring.



You can keep an eye on your Twins Series PSU and be alerted to problems in real-time thanks to software monitoring.

"One of the peculiarities of this system is that it is the only one that can cram 32GB of memory into a 13.3-inch form factor."



LAPTOP

FROM \$1,400 (CORE I5 MODEL) | WWW.FUJITSU.COM/AU

Fujitsu LifeBook E736

Could this be the perfect mobile workstation?

Let's get to the point: the Fujitsu LifeBook E736 is an expensive laptop. But according to its manufacturer, it delivers uncompromising elegant design and functionality.

The E736 just about qualifies as an ultrabook. It's 20mm thick and weighs 1.6kg, despite looking like a slab. Part of that surprising light-footedness is down to the use of magnesium in the lid and aluminium in the palm rest, which gives the latter a rather odd artificial smoothness.

One of the peculiarities of this system is that it is the only one that can cram up to 32GB of memory into a 13.3-inch form factor. Such a massive amount of RAM is ideal for memory-intensive applications.

Fujitsu opted for a classic look with a gunmetal lid and a red border that runs across one edge. Because of its metal palm rest, the first thing that strikes you when opening this machine up is how cold the chassis is.

The display is attached to the base via two hinges. We noticed a lot of flex in the display, the sort usually associated with entry-level laptops. The keyboard also showed some flex during long typing sessions. This didn't affect our working experience. The keyboard has a longer-than-average travel, and the keys are soft to the touch, while the touchpad is big and responsive enough with two physical buttons.

A fingerprint reader on the palm rest, joins a pair of tiny speakers (generating a boxy sound without much depth); five status lights; and the power, Wi-Fi on/off and Eco mode buttons above the keyboard.

The amount of raw power packed in the E736 is impressive. Not once did we encounter any sort of stuttering, as you would expect from such a beast. The fan did kick in a few times but not to any worrying extent. Fujitsu allows you to disable it completely via the BIOS (via

F2) but we'd suggest keeping things as such, otherwise the CPU speed will drop in such a way as to prevent too much heat from being generated.

As expected, battery life was exceptional on our test unit. It managed to last 12 hours playing an MKV file with sound and brightness set at 50%.

But the LifeBook E736 won't appeal to everyone. Its price and design drew blanks on the faces of some of our consumer-oriented colleagues, but this laptop is more suited to a business user. It does score high points when it comes to modularity/expandability, performance, manageability and battery life. The particular model we tested isn't available at retail in Australia: it's packed in 32GB of memory, whereas the nearest equivalent has 8GB. Regardless, there's still the option of up to 18-hour battery life (with less-intensive tasks) via the addition of a secondary battery which takes the weight to 1.75kg. There's also an optional Port Replicator,

which we loved. It's compact and offers more connectivity options, but it's a shame that it doesn't support 4K.

At the time of print, street prices varied significantly for the Core i7/8GB/256GB model of the E736 (the nearest to what we tested), around \$1,900-\$2,300. That lower price is a reasonably fair one, although the 256GB size of the internal SSD is perhaps a little small, but that's alleviated by the modular drive, which can take a second hard drive.

This is one of the best business laptops available, but its value does very much depend on how much you can find it for. ■ Desire Athow

Verdict

Features
Performance
Value



A great business laptop; shop around to find the Core i7 model for under \$2,000 to get the best bang for your buck.





GAMING LAPTOP

\$2,300 | WWW.ASUS.COM/AU

ASUS Strix GL502VT

A future-proofed gaming laptop that costs less than you might think.

ASUS's Strix GL502VT is far from heavy. Not everyone will like its appearance, but you couldn't call it bad-looking. And while it's not quite a bargain, it's reasonably priced for the specs.

We were expecting the GL502VT to be a simple upgrade of something like the GL552W (reviewed in our sister mag *TechLife* – issue 51, page 52) that would lead to a decent middle-of-the-road gaming laptop, but once you get past the facade, the differences seep in.

We've noticed a trend with laptop manufacturers of late only installing SSDs in their gaming-oriented models, and that's the case here, too. That's a bit of a double-edged sword, as makers are often sacrificing much larger HDDs in order to do so and it can be a design decision that makes the gaming laptop about as useful as a bucket full of holes – at least if you want to have more than a few games installed at a time.

While we can certainly understand the appeal of the Samsung PCIe M.2 SSD that ASUS has used here – with its 2,000MB/s read and 400MB/s plus write speeds – that 256GB capacity is likely to leave you wanting more space sooner rather than later – especially if you'd like to throw some HD movies and TV or other big media files on there alongside your games.

The other notable upgrade of the GL502VT from the GL552W is the addition of a 4K IPS display. But again, a 4K display is a bit of a mixed blessing. Attached to a powerful desktop gaming rig, they can deliver a great experience, but you're not going to be gaming in 4K on the GL502VT – the internal hardware is not that fast. So apart from having a sharper image and being able to stream 4K video content on it, the usefulness of this display is somewhat limited.

There's another downside to that screen – the strain it adds to battery life. The GL502VT netted just 2 hours

and 33 minutes in our PC Mark 8 Home battery-life test – and that was with the battery-saver optimisations on. Switch to high-performance mode and you'll only reach around 1 hour and 14 minutes.

The Intel i7-6700HQ CPU and the Nvidia GeForce GTX 970M GPU come together nicely here, easily pumping out respectable frame rates on the latest titles at 1080p. The GL502VT matched the scores of the 2016 Alienware Alpha (a device which uses a desktop-class GTX 960), with average frame rates of 59, 35 and 72 from *Batman: Arkham Knight*, *FarCry Primal* and *Rainbow Six Siege* on high and ultra settings. The chassis does get warm in certain hotspots above the keyboard when it's under load, but the CPU and GPU both remained under 81°C, a fairly safe level, throughout our tests.

The GL502VT's keyboard is full-sized, yet it's ditched any space around the number pad and even a few

of the keys to make it slot in Tetris-style on the right of the directional keys. The speakers aren't great, despite sitting particularly close to each of your ears on either edge of the base of the unit, roughly in line with the trackpad.

Still, we were surprised the street price landed at a reasonable \$2,300 for the 4K model, so it's hard to be too harsh about the cutting-edge technology slicing both ways. And at 2.2kg, the beefier hardware hasn't made the device unwieldy by any means either – this is a gaming laptop that's not too painful to cart around with you. ■ Joel Burgess

Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

Reasonably priced for the specs on offer and not too heavy, but with fairly mediocre battery life.





\$1,899 | WWW.DELL.COM.AU

Dell Inspiron 13 7000 (2016)

Dell redesigns its 13-inch 2-in-1, with fairly pleasing results.

This isn't the first Inspiron 13 7000 we've seen from Dell. Compare this 2016 edition with the earlier model from 2015 and you'll find price has jumped up a couple of hundred dollars, with the most significant changes being new 6th-gen Intel parts – specifically a new CPU and GPU. At this \$1,900 price, that includes a dual-core Core i7 processor, along with Windows 10, 8GB of memory and a 256GB SSD.

Dell has replaced the stubby stylus with this new model, and one of the USB ports has been swapped to USB Type-C (there are still two other regular Type-A USB 3.0 ports). The chassis has also changed subtly – and we actually prefer this new design. It's perhaps a little squarer and more conventional, but also comes across as more premium and professional. The main body uses a single piece of metal that wraps around the edges,

a design which gives the whole thing a very solid and rigid feel. The keyboard keys are nice and stable and the surrounding metal base doesn't flex when you're typing or using the trackpad, unlike what you'll find on cheaper plastic laptops. There's also a slight dip in the chassis below the trackpad that makes resting your hand there a little more comfortable and creates a lip you can use to pry open the display.

The trick that makes this unit a 2-in-1 is a screen that flips around almost 360°, transforming it from a laptop into a serviceable (if not exactly svelte) tablet. Flipping the screen right around is a relatively smooth and straightforward action, aided largely by a pair of discretely chunky and sturdy hinges.

The 13.3-inch touchscreen has a glossy finish and produced nice clear visuals with relatively naturalistic

colours, though it does have an antiglare coating that gives off a vague "oil-slick" sparkle that can be quite visible against a white background.

Battery life could be a little better – 3:38hr isn't a bad result for PCMark 8's tough Home test, but it only added an extra hour, reaching 4:40hr, for watching a 1080p movie. Other 13-inchers we've recently tested, like the HP Spectre 13 and Acer Aspire 5 13, have managed nearly 6 hours in the latter test.

As a tablet, the 13 7000 is also serviceable but not particularly compelling – the general thickness and weight, and the wide and uneven black bezels around the entire screen all make it less appealing to use as a slate than a 'true' tablet like, say, a Surface Pro. This is definitely a laptop first and a tablet second – and at 1.6kg, this isn't a device you can hold in one hand. But it's a

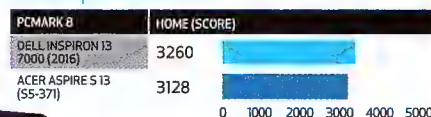
neat option to have, and 'tent' mode – where you turn the screen around 270° and use the front edges to prop it up – is also useful for space-restricted touchscreen use, like following along with a recipe in the kitchen.

Dell has included some convenience features here – an IR camera means you can log into the machine using Windows Hello's face-recognition tech and the included charger is compact and fairly lightweight.

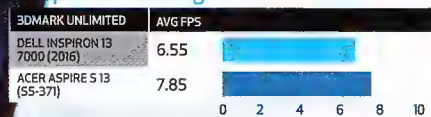
In all, this one's few shortcomings are fairly easy to overlook. ■ Dan Gardiner

LABS BENCHMARK RESULTS

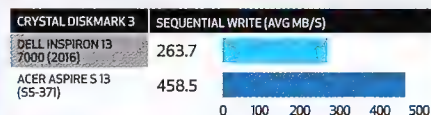
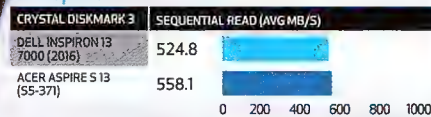
General performance



1080p media encoding



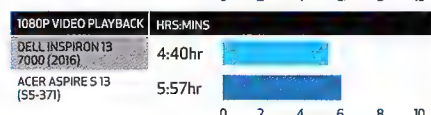
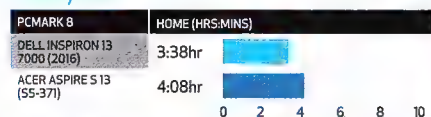
Disk speed



Gaming performance



Battery life



Verdict

Features ★★★★★
Performance ★★★★★
Value ★★★★★

A tough-feeling little unit with lots of pleasing features. Recommended.

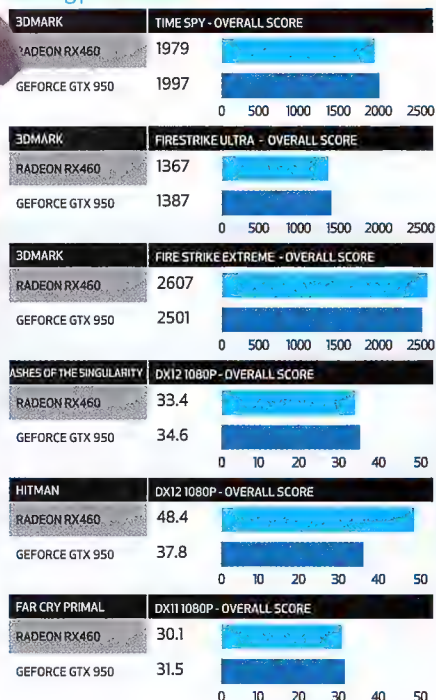




GRAPHICS CARD
\$220 | WWW.AMD.COM

LABS BENCHMARK RESULTS

Gaming performance



AMD Radeon RX 460

AMD's new entry-level card is optimised for affordable gaming.

While powerful GPUs are necessary for many games, those of us who just want to play *League of Legends* or *DOTA 2* can get away with lower-end hardware. The AMD Radeon RX460 has been specifically designed and built for affordable eSports gaming, at 1080p. At the time of writing, the cards are available from as little as \$220.

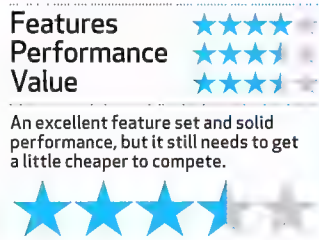
The Radeon RX460 is based on the AMD Polaris 11 architecture, as opposed to the Polaris 10 for the RX 470 and RX 480. It's replacing the older Radeon R7 260 and 360 series GPUs, and is designed to be a lot more efficient. The RX460 is built on a 14nm FinFET (3D Transistor) process, has 896 stream processors, 14 active compute units, and stock can boost up to 1,200MHz. The card also used either 2GB or 4GB of GDDR5 memory, with a 128-bit

bus. It also supports asynchronous compute, is HDR ready, handles DirectX 12 and FreeSync, and can encode/decode H.265 at 60fps. The particular model we have for testing is the Sapphire Nitro Radeon RX 460 OC 4GB. Rather than the compact stock cooler, the Sapphire card has a chunky dual slot heatsink with twin fans. While the stock RX 460 doesn't need it, the overclocked Sapphire version has a single 6-pin power connector, though will run without. Round the business end, the GPU has HDMI, DisplayPort and DVI, and can run three displays at once. Something to note for media enthusiasts – the HDMI port is 2.0 spec, for HDR, 3D and higher frames per second 4K resolutions. The Sapphire RX 460 pushes the stock boost frequency up 50MHz, to 1,250MHz, in an effort to eke out a little extra oomph.

For testing, we put the RX 460 up against its closest Nvidia rival, the GeForce GTX 950 (in this case, from MSI). The GTX 950 has been around quite a while now, and can be bought from around \$200. We tested a range of games and synthetic benchmarks, at 1080p resolution, using a high-end CPU to ensure no GPU bottlenecking. Performance on less-intense titles such as *League of Legends* is great, and even with the detail level at maximum, the card will exceed most monitors' refresh rates. Average frames rates will depend on exactly what is on screen, but we didn't see it drop below 90fps. The RX 460 also doesn't shy away from more-intense games, but generally, the quality level needs to be dropped back. For example, when testing *Ashes of the Singularity*, the card tops out at just 29 frames per second on high, whereas standard gives

33fps, and low averages at 48fps. Unfortunately, the performance is not so rosy when we start comparing to the cheaper GTX 950. The RX 460 can pull ahead in DX12 titles, but under DX11, the 950 gives better bang for buck. Sure, both run less intense games at 60+fps just fine, but the RX 460 needs to drop in price before it is truly competitive. Of course, it's worth noting that the RX480 has some great features not found elsewhere (such as FreeSync), which can skew the balance back in its favour. ■ Lindsay Handmer

Verdict



"With a maximum overclock of 4.5GHz it doesn't reach the 4.8GHz heights of the 6700K, but it's starting with a 600MHz disadvantage in terms of peak Turbo speeds."

✓✓✓
apc
RECOMMENDS

INTEL® CORE™ i7
i7-6800K
SR2PD 3.40GHZ
J604C745 (E4)
769UD84201280

CPU

\$690 | WWW.INTEL.COM

Intel Core i7-6800K

Six cores are better than four, right? Right?

We've already locked horns with the daddy of Intel's new family of uber CPUs, known as Broadwell-E. What a monster the Core i7-6950X is, all 10 cores and 20 threads of it. However, the 6950X is also a \$2,579 slice of silicon. Value may be in the eye of the beholder, but that price is just silly.

In that context, the new Core i7-6800K looks intriguing. At around \$690, it's roughly a quarter the price of the 6950X. But with six cores and higher clocks, it's at least two-thirds the chip. It's also the latest entry-level model for Intel's big-iron X99 platform and the LGA2011-V3 socket.

In many ways, then, the real comparison is with the Core i7-6700K on the mainstream LGA1150 socket, for around \$200 less, plus savings on motherboard and RAM costs.

So let's deal with the 6800K's speeds and feeds. Like the rest of the Broadwell-E crew, it's a 14nm chip, but not based on

Skylake. Since Intel split the desktop into two platforms, the high-end option has derived from server CPUs that lag mainstream desktop architecture by a generation. And so it is here.

However, for CPU features, that isn't much of an impediment. Along with six cores and 12 threads, running at 3.4GHz nominal and 3.8GHz Turbo, you get 28 PCIe 3.0 lanes and 15MB of cache. Factor in the quad-channel DDR4 memory interface, and there's no question that the LGA2011-V3 platform is a bandwidth monster with which the likes of Intel's mainstream CPUs and mobo chipsets cannot compete.

But how much effect does all that have on real-world usage? The answer is that it depends on what you're doing. In efficiently threaded software, like video encoding or professional graphics rendering, the six-core 6800K has the edge over its cheaper quad-core sibling. The gap isn't huge. The 6800K scores 1,099 in

Cinebench, for instance, to the 6700K's 908. In x264 encoding, it's 23.85fps against 20.54fps. But the 6700K is a little higher clocked, offsetting those extra cores.

Elsewhere, it's a patchier story. The 6800K has a slight edge in the synthetic 3DMark Fire Strike benchmark, but it's neck and neck in *Rise of Tomb Raider*. Then in *Total War: Attila* it actually trails the 6700K's 55fps, at 52fps. When it comes to games, few titles clock speed well beyond four cores. Clock speed, in other words, counts.

Nor does the 6800K have a huge advantage when it comes to productivity metrics, including file compression or the PCMark 8 Creativity test. The 6800K also consumes significantly more power than the 6700K. However, when you factor in overclocking, the picture improves. With a maximum overclock of 4.5GHz, it doesn't reach the 4.8GHz heights of the 6700K, but it's starting with a 600MHz

disadvantage in terms of peak Turbo speeds.

Which means the 6800K's proposition is finely balanced. As a gaming chip, it makes no sense. It's not a slam dunk as a pure high-performance desktop CPU, either. However, consider the platform advantages: memory bandwidth, PCIe connectivity, and an upgrade path all the way to 10 cores. Then add overclocking to the equation. Suddenly, the 6800K makes a lot of sense, even with the cost of an X99 mobo and quad-channel memory. It won't suit everyone, but for some, it will be pretty much a perfect processor. **Jeremy Laird**

LABS BENCHMARK RESULTS

General performance

CINEBENCH R15	OVERALL SCORE
INTEL CORE i7-6800K	1,099
INTEL CORE i7-6700K	908

TECHARPS X264	FPS
INTEL CORE i7-6800K	23.85
INTEL CORE i7-6700K	20.54

MEMORY BANDWIDTH	GB/S
INTEL CORE i7-6800K	43.29
INTEL CORE i7-6700K	28.76

5GB COMPRESSION	SECONDS
INTEL CORE i7-6800K	132
INTEL CORE i7-6700K	143

3DMARK FIRE STRIKE	OVERALL SCORE
INTEL CORE i7-6800K	17,468
INTEL CORE i7-6700K	17,016

TOTAL WAR: ATTILA	FPS
INTEL CORE i7-6800K	52
INTEL CORE i7-6700K	55

TOMB RAIDER	FPS
INTEL CORE i7-6800K	68
INTEL CORE i7-6700K	67

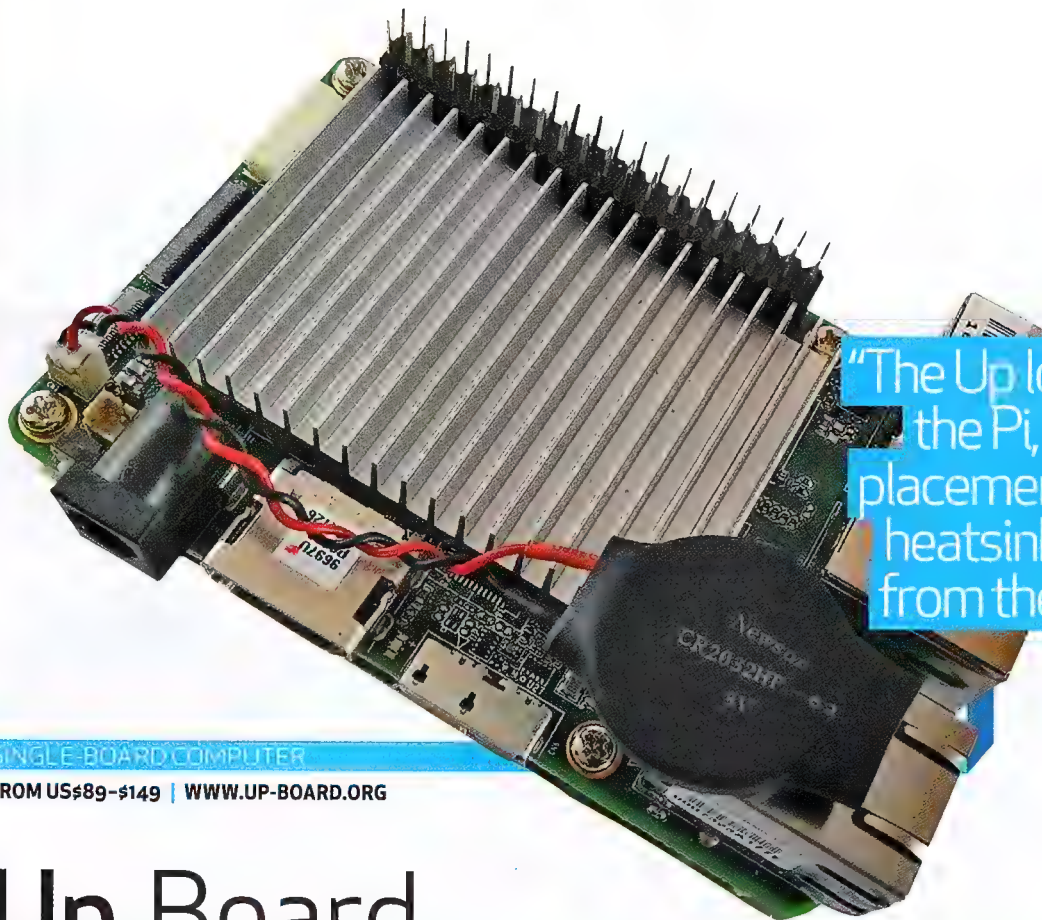
Verdict

Features
Performance
Value



Easy access to HEDT; good multithreading; strong overclocker. Mediocre single-core performance.





"The Up looks similar to the Pi, but a few port placements and a large heatsink differentiate from the competition."

SINGLE-BOARD COMPUTER

FROM US\$89-\$149 | WWW.UP-BOARD.ORG

Up Board

A single-board computer that offers an alternative to the Raspberry Pi.

When it comes to single-board computers (SBC), the ARM CPU has near dominance with the Raspberry Pi, of course. But a recent Kickstarter has created a new Intel-based SBC alternative. The Up Board comes in a variety of RAM and flash storage configurations, and we tested a board with 2GB DDR3 RAM and 16GB of eMMC flash storage.

Powering the board is an Intel Atom x5-Z8350 with a quad-core 1.44GHz CPU that can scale to 1.92GHz. This is a powerful CPU for such a small board. The layout of each version of the board is identical with only changes to RAM and storage on offer. There are four USB 2.0 ports, as well as a USB 2.0 breakout port, Gigabit Ethernet, USB 3.0 and HDMI.

Power is provided by a 5.5mm jack. The Up Board requires a minimum of 5V 3A to operate, but for best results, it's advised to use a 5V 4A power supply. On the

top of the CPU is a large heatsink, along with another underneath. This heatsink is necessary as the Atom CPU can get rather warm, so good ventilation is a must for prolonged use.

The Up comes with a 40-pin General Purpose Input Output (GPIO) that provides a similar experience to the Raspberry Pi. This offers control of pins using SPI, I2C, PWM and standard digital on/off. To control the GPIO, we used the RPi.GPIO Python library, which works exactly like the Raspberry Pi, but sadly, we were only offered a Python 2 library. The Up also isn't compatible with Raspberry Pi add-ons.

Being an x86-based CPU that has a UEFI BIOS, it's possible to install many different flavours of Linux onto the board, but we installed the Ubilinux custom Linux distro for Up. Ubilinux is based on Debian Jessie and the latest version comes with kernel 4.4, a very recent kernel release. Installation only takes 2GB

of the 16GB eMMC, leaving plenty of space for projects.

Being a typical Debian distro we were able to update and install new software using the APT packaging tool, and we used it to install the IDLE Python editor and htop, a dashboard of system resources in the terminal. We also tested the latest Ubuntu 16.04.1 release and were pleasantly surprised to see that it worked flawlessly.

All versions of Up come with a USB 3.0 OTG (On The Go) connector, so we tested an external USB 3.0 hard drive and copied a 1.4GB Ubuntu ISO image from the internal eMMC to the hard drive. Using USB 3.0, the transfer took 14 seconds at approximately 100MB/s. Compared with USB 2.0 which took 38 seconds at approximately 36.3MB/s, we see a massive jump in transfer rates.

The Gigabit Ethernet works as expected, but none of our WI-FI dongles worked with Ubilinux so we were unable to test this feature – a bug that's being worked on.

As part of our tests, we ran the ioquake3 demo to test the Intel graphics. Our tests at 1,152 x 864 pixels with 32-bit texture detail maxed out at 90fps (70fps on the Pi 3). Using Sysbench to calculate Pi, the Up took just 59 seconds against the Pi 3 at 120 seconds. The Up also has AES acceleration, running an OpenSSL 4096 sign test the Pi 3 managed 20 per second, the Up hit an impressive 75 per second.

Overall, the Up board is a powerful platform that can offer an experience similar to the Pi, but is the extra performance worth the cost?

■ Les Pounder

Verdict

Features
Performance
Value



If you need lots of power in a small chassis, then you can't go far wrong and this is ideal for a server project.





INTERNAL HARD DRIVE
\$1,100 | WWW.SEAGATE.COM

Seagate Enterprise Capacity 3.5 HDD (Helium) 10TB

For those who need massive storage.

For business and high-end home use, an enterprise-level drive is a must for extra features and reliability. The latest drives are now available in a 10TB capacity, which makes it easier to maximise storage density. But considering the HDD costs \$1,100 (~30% more than the BarraCuda Pro, right), what exactly do you get for the money?

The Helium drive spins at 7,200rpm, has 256MB of cache, is rated for 24/7 operation, and is backed with a five-year warranty – the same as the BarraCuda Pro. Where the Enterprise model stands out is the high 550TB a year endurance (up from 300), which makes it ideal for high workload environments. It also has a 2.5 million hour MTBF rating, and is good for 600,000 load/unload cycles.

For testing, we have the standard SATA 512E

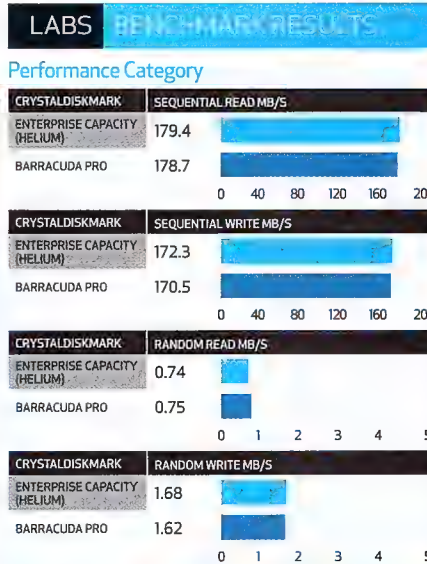
model, but the drive is also sold as a 4KN disk format version, with either SATA and SAS interfaces. In testing, we managed an excellent (for a traditional HDD) 179.4 / 172.3MB/s sequential read and write, and 0.74 / 1.68MB/s random read and writes.

So why is the drive filled with Helium, rather than air? The lower density and slippery nature of helium means that the moving parts inside have less drag, which means less power use, lower temperatures, and less wear. All these improvements allow Seagate to squeeze seven platters into the drive, along with 14 heads, without compromising reliability.

■ Lindsay Handmer

Verdict

Expensive, but with enterprise-level features and reliability that are must have for professional use.



INTERNAL HARD DRIVE
\$829 | WWW.SEAGATE.COM

Seagate BarraCuda Pro 10TB

A slightly cheaper 10TB option.

Enterprise drives have loads of advantages, but are overkill for most home or even small business use. To provide a more affordable option, Seagate has released a 10TB BarraCuda Pro drive, which costs around \$829. Like its more expensive brother, the BarraCuda Pro has a 7,200rpm, 256MB of cache and rated throughput of 220MB/s. The key differences, though, are in the intended use.

Seagate has positioned the drive for 24/7 use in high-performance desktops, such as those used by creative professionals and gamers. Compared to the normal BarraCuda, the Pro bumps the warranty up from two years, to five years, in line with the Enterprise options. The Pro is also available in 6TB, 8TB and 10TB capacities, whereas the normal drives stop at 4TB.

Where the BarraCuda Pro falls short of the more expensive Enterprise drive

is reliability. That's not to say it's not a reliable drive, but Seagate doesn't provide an MTBF. It still has a load/unload rating, which is the number of times the drive is rated spin up and down. The BarraCuda Pro is rated for 300,000 cycles – half that of the Enterprise drive. It's also got a lower 300TB per year endurance, (vs 550 for the Enterprise drive) but is loads better than the normal BarraCuda's 55TB.

In real-world use, the drive performed quite well, with an excellent 178.7 and 170.5MB/s sequential read and write speed. Random access is also decent for this sort of drive, at 0.75 and 1.62MB/s reading and writing, respectively.

■ Lindsay Handmer

Verdict

A very large-capacity single drive with excellent warranty and features for higher-end use.





PC CASE

FROM \$300 | WWW.ANTEC.COM

Antec Signature Series S10

We've been spoilt for far too long.

Antec's Signature Series S10 is a \$300 behemoth. The glinting aluminium greets you boldly as you unbox this towering colossus from its over-engineered hard-foam packaging. The 3mm-thick metallic alloy exudes strength; the hinges, less so. The vast bulk weighs 17.6kg.

The S10 is split into three separate compartments. You have the main motherboard segment, which is finished with a floor panel, creating a separate PSU and 2.5-inch drive segment, then a separate compartment developed for hard drives at the front. This part of the chassis is entirely separate from the main bulk, attached only briefly by passthrough points. What this does, other than look glamorous, is allow cool air to pass in between and be drawn into the main motherboard compartment, through the triple 120mm fans. However, if you plan on populating the front with

hard drives, you may want some longer SATA power extensions cables.

Cooling in the main chassis is provided by up to three 120mm fans in the front, two 140mm fans in the roof, and one 120mm fan in the rear. You also have the option to include a 120mm fan in the PSU chamber, and one in the hard drive chamber. However, space is tight in the main compartment once fans are installed and that lack of internal capacity doesn't allow for any thicker rads to be installed.

Who is this for? Someone wanting a low-maintenance, power build. It's easy to work with, but we have to question Antec's decision to list this case at such a high price point. ■ Zak Storey

Verdict

Aluminium panels; innovative hard drive cage; good airflow; easy to build in, but price is a problem.



PORTABLE PROJECTOR

\$699 | WWW.SONY.COM.AU

Sony MP-CL1

A genuinely pocketable projector that's great for travelling night-owls.

Sony's pocket projector is no bigger than a large mobile phone and its black metal chassis gives the projector an understated class that is reflective of the money you'll fork out for it.

In addition to a micro-USB charging port, there's also a MHL HDMI output, 3.5mm headphone jack and a USB output, letting you use it as a powerbank. Like a number of pico projectors, the MP-CL1 uses LED-based projection so you don't have to worry about focusing the device, having to replace an expensive projection lamp, or waiting for that lamp to warm-up before use.

The MP-CL1 isn't the brightest projector, pushing a meagre 32 lumens (most home theatre projectors produce around 1,500), but what it lacks in shine, it makes up for with an impressive 80,000:1 contrast ratio and a high 1,920 x 720 resolution. While that lower brightness makes the MP-CL1

practically useless in the daytime, fire the device up in the dark and you'll get an image that looks excellent up to about an 80-inch projection size.

If you happen to have a recent smartphone, then you can use the Wi-Fi-based Miracast to connect to the MP-CL1 wirelessly, which will allow you to connect to Bluetooth speakers without interference (or use the AUX out).

This projector can play through a 90-minute film with a 40- to 80-inch picture on a single charge – with sound. What's more, that 3,400mAh internal battery lasts up to 2 hours if you're not using the projector's own speakers, which are really a last resort option anyway. ■ Joel Burgess

Verdict

A compact and portable projector with surprisingly good battery life and excellent image quality.





MONITOR

\$249 | WWW.VIEWSONIC.COM.AU

ViewSonic VX2757-mhd

A strong contender at the affordable end of the gaming monitor market.

These days it's surprisingly easy to build a pretty decent gaming PC on a tight budget, but the available monitors in the 'budget' price range tend to leave a lot to be desired. And that's where the ViewSonic VX2757-mhd comes in - an affordable 27-inch screen that has (almost) everything a gamer needs for just \$249.

The underlying spec is pretty good, with a matte TN panel, 1080p resolution, a 1ms (grey-to-grey) response time, a 1,200:1 contrast ratio and HDMI, DisplayPort and VGA inputs. The screen also uses a 75Hz refresh rate, which is a great step up compared to the more common 60Hz on entry-level (and non-gaming) panels. Perhaps most importantly though, the monitor includes AMD FreeSync tech. On a normal screen, mismatches between the refresh rate and in-game frame rate can cause frustrating tearing and stutter effects. With

FreeSync, an AMD GPU can with together with the VX2757-mhd (although over DisplayPort only) to dynamically adjust the refresh rate for a smoother and more immersive experience. The ViewSonic monitor is also designed to have a very fast input response, to give every advantage when gaming.

In real world testing, panel is bright (300cd/m²) and vibrant, though it can still benefit greatly from some manual tweaking of the settings. There is minor backlight bleed around the edges, but it's pretty good for the price. Being a TN panel, the colour accuracy and viewing angles aren't perfect, and there's an almost unnoticeable amount of ghosting, but once again, it's comparatively excellent for a panel that's this affordable.

The VX2757-MHD uses a dynamic contrast ratio and has a game mode that helps to improve detail and visibility in dark games.

FreeSync on the VX2757-mhd operates from 47- up to 75Hz, and despite long, arduous bouts of gaming, we didn't experience any real tearing or stuttering in that range. ViewSonic don't include a DisplayPort cable in the box (only HDMI), so that's an extra expense if you want to actually use AMD FreeSync.

The OSD is decent, but it's a little fiddly at first to actually operate the buttons. The matte panel surface (anti-glare, 3H hard coating, Haze 25) does a good job at avoiding any reflections. The monitor does have built-in dual 2W speakers, but like any at this price point, they're fairly tinny, and really handy as a backup option. In terms of power draw it's pretty good too: over a week's worth of testing, we recorded an average of 24W power usage.

When getting set up, it's nice to note that the monitor power cable plugs in directly without a brick, and the stand includes a handle

little cable management clip. The screen features a basic tilt adjustment between 23 and -5 degrees. The VX2757-mhd is covered by a 3-year warranty onsite pickup and return warranty, along with a 30-day perfect pixel period.

While we tested the 27-inch model, the ViewSonic VX57 series actually includes 24- and 22-inch models too. They share the same 1080p resolution and 1ms response time, as well as other key specs and gamer focused features such as FreeSync. Even better, both models are available for just \$169. ■

Lindsay Handmer

Verdict

Features
Performance
Value



A top notch collection of gaming centric features for an incredibly affordable price. A great budget gaming option.



GIGABYTE™



Gaming Like You've Never Seen Before

GIGABYTE BRIX Gaming UHD is equipped with the compact design that fits anywhere, rapid computing speed, and the stunning visual effects. All these together, GIGABYTE BRIX Gaming UHD brings you the ultimate gaming experience.



B-BNi7HG4-950

Ultra Compact PC
Only 2.6L

Discrete Graphics
NVIDIA GTX 950

USB 3.1 in
Type-A / Type-C

Multiple 4K
Display Support

Ergonomic
Thermal Design

Dual 2.5" SSD
or HDD Support

Dual M.2 PCIe
SSD Support



Intel® Core™ i7-6700HQ processor
Intel Inside® • Extraordinary Performance Outside®



Where to buy

<http://www.gigabyte.com.au/where-to-buy/where-to-buy.aspx#106008000-2>

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WIRELESS GAMING HEADSET

\$170 | WWW.RAZERZONE.COM

Razer ManO'War

The wireless conundrum.

Another month, another wireless headset. The Razer ManO'War is nothing short of awe-inspiring to look at it. Its clean lines, simple black design and elegant feel will appeal to those looking for a more premium headset. It's a step away from the more outlandish offerings Corsair recently brought to the table, and far bulkier and classier than Turtle Beach's wireless headsets, as well. But, alas, looks are only one part of the story.

It's safe to say we've not always been fans of Razer's more recent cans here at APC. The Kraken Pros, for instance, lacked the higher reaching treble found within the likes of the HyperX Clouds or Corsair's USB Voids. Coupled with the overwhelming gaming bass, basic comfort options, and overall pricing structure, it all felt just a little out of touch. The ManO'War looks to correct that.

It features 50mm dynamic drivers, with a frequency

response ranging from 20Hz to 20kHz — nothing overly exceptional. The impedance is the standard 32 ohms, and SNR sits at a decent 112dB. What Razer has managed to work in here is some exceptional EQ balancing. As standard, the ManO'War sounds crisp, well balanced, and rounded. Its mids and trebles are dependable, its bass not too overpowering.

However, the soundscape isn't as wide as we'd expect from a headset at this price, no doubt due in part to that limited frequency response. But does it actually make a difference? After all, human hearing supposedly only operates from 20Hz to 20kHz. Well, in our opinion, yes, it really does; in the same way it makes a difference listening to a FLAC audio file as opposed to an MP3. The lower and upper sound frequencies buried within each piece of audio can resonate, can ring out without being cut off at the tip.

That's not to say that the audio quality is bad on the

Razer ManO'War, just that it could be better.

That aside, the ManO'War performs admirably. The microphone is a strong contender, the range is good and the overall look and design is great. The earcups are exceptionally comfy, and the semi-open back style keeps you aware of your surroundings in and out of game. On top of that, it provides a bit of relief when your ears get too hot. But the headband is a little on the thin side, and the sharp angles and edges of the plastic frame covering the metal support band can cut into your head a little, certainly if your hair is either missing or shorter than most people's.

As for battery life, the ManO'War is rated to operate for a total of 14 hours of continuous use with the LEDs on, or 20 hours without. We can't understand why you'd want to run this headset with LEDs on, for as much as they look great, it doesn't make sense to part with six hours

of battery life, all for the sake of something you can't even see when you're using it. In testing, we plugged the headset in at night, every night. Just to be safe. It saves faffing about with a cable mid-game.

All in all, Razer's ManO'War is a solid enough headset, just as long as it's in the right hands (or on the right head). If you're careful with your positioning, have a full head of hair, and don't mind the simpler soundscape, then it's ideal. However, for us, there are simply too many kinks to let both it and wireless headsets in general off the hook just yet. ■ Zak Storey

Verdict

Features
Performance
Value



Well-balanced audio and solid accessory kit, plus good battery life and a quality mic. Audio quality could be better.





apc
RECOMMENDS

MECHANICAL GAMING KEYBOARD

\$290 (EB GAMES EXCLUSIVE)
BLUEMOUTH.COM/OZONE-STRIKE-PRO-KEYBOARD

Ozone Strike Pro

Backlit mechanical gaming keyboard.

It's a special kind of mechanical gaming keyboard that allows you to use it for both work and play. Some might call it 'unremarkable' in design, but we prefer the term 'flexible'.

The Strike Pro's frame is quite compact around the sides, but it has a decently-sized wrist rest that's relatively comfortable to use when lying flat – the angle with the feet raised isn't kind on the wrists during extended gaming sessions. The matte-black surface is fingerprint-resistant and the shape of the Cherry brown-switched keys is nicely convexed, while the spacebar is gently concave.

Once plugged in, Esc, Q, E, WASD and the arrow keys blaze with red LED backlighting, with everything else glowing white. The intensity of those lights can be dimmed via the Scroll Lock button, but the red lights unfortunately don't change in sync, remaining vivid. The F-keys support media adjustment

controls, and if you initiate 'Game mode', the Windows key is disabled, just in case you accidentally tap it mid-fight. It likewise has anti-ghosting tech and sports six programmable macro keys that double as the Insert, Delete (and so on) group, with the ability to save up to 30 different personalised configurations.

We liked the fact that there are ports for mic, headphones and USB discretely placed on the top right. In terms of the cost, though, for \$290, you could frankly get yourself a keyboard with a lot more bells and whistles. But if money's no object and you just want a nicely designed gaming board that isn't covered in gimmicky keys, go for it. ■ Carmel Sealey

Verdict

A keyboard fit for work and play, with a sprinkling of customisation options, but rather pricey.



apc
RECOMMENDS

MECHANICAL GAMING KEYBOARD

\$159 | WWW.HYPERXGAMING.COM

HyperX Alloy FPS

Say 'Allo(y)' to a refreshingly no-frills gaming keyboard.

This is HyperX's first gaming keyboard. Despite the 'FPS' in the name, this isn't just a keyboard for first-person shooters. It's fine for use with any type of game and generally stands up well for regular typing.

The underside of the keyboard is plastic but that's topped by a heavy slab of iron alloy that makes it both weighty and rigid – this board doesn't move around at all once you've plonked it down. There's no frame around the outside edge of the keys either, so viewed side on, the switches underneath each key are clearly exposed.

HyperX's engineers have, commendably, largely focused on utility and function elsewhere too. There's only one switch type (the super-clacky Cherry Blue), the LED backlights aren't the configurable multicoloured RGB type (you get red lighting, and that's it), there are no macro keys, and you don't need to install any drivers, as the

built-in extra features like media controls (volume, play, pause and so on) and backlighting brightness are accessed via Function key combinations.

You get swappable keycaps for the main gaming keys (W, A, S, D and 1, 2, 3 and 4), so you can switch the default black ones to be red – and those replacement WASD caps are textured, making them easier to locate by touch alone. The USB cable is braided and detachable.

In sum then, if you're a fan of Cherry Blue switches and looking for a no-frills board that focuses on function rather than flashy features, there's a lot to like here – and it bodes well for future HyperX gear, too.

■ Dan Gardiner

Verdict

Functional and not drowning in features. Easy to recommend, if you like Cherry Blue switches.





GAMING HEADSET

\$99 | WWW.DELL.COM.AU

Dell Performance USB Headset AE2

Dell-ving into the gaming headset market.

We wouldn't have been surprised if Dell's first foray into the USB gaming headset arena went largely unnoticed. Not just because the computer manufacturer's brand isn't generally associated with headphones, but also because everything from the product name to the headset's design is, well, just a bit unassuming.

The black plastic headband runs down to two large black over-ear muffs that are generous (even for a gaming headset) and allow it to fit big 40mm neodymium drivers in each side. These speakers are a bit dull when it comes to straight stereo music listening, but push through 5.1 or 7.1 surround sound audio files and you get a real boost to your sense of spacial location. There are only two drivers, so it's just virtual surround sound, but among headphones in this sub-\$100 price bracket, we found nothing as good.

Dell at least has picked an experienced hardware

running-mate with SteelSeries, with the latter actually building the AE2s, but this headset also benefits from access to SteelSeries' Engine 3 peripheral software. Not only does this (optional) application allow you to create custom presets for the headphone's equaliser and LED colour display, settings can be set to automatically change when certain programs are opened, allowing you to map separate audio profiles for gaming and music.

The AE2's chunky USB cable is less malleable than we'd like and the microphone positioning — embedded into the left can — made it a little quiet, but all up, this is a well built headset that's worth the \$99 asking price, if only just. ■ Joel Burgess

Verdict

A good headset for gaming with impressive virtual surround sound for the price.



2.1-CHANNEL SPEAKERS

\$449.95 | WWW.CREATIVE.COM

Creative T4 Wireless

The top end of old-school 2.1 speakers.

Finding a decent set of premium 2.1s today is hard work. The big brands, such as Logitech, Antec and Corsair, have almost stifled research and development into this type of audio solution. So if you want the best of 2.1, where do you turn? To Creative.

Opening the box, you're greeted with two small, stylish tweeter satellites, featuring a stunningly polished chrome top, black base, and single driver. Although you can't adjust the angle of these two speakers, they are naturally slanted slightly upward. Thanks to their minuscule size, they're easy to position on even the most cramped of desks. The aluminium drivers provide a crisp and rich sound — there's a real depth to them, especially in combination with the subwoofer. Arguably, for value for money, it hits the nail on the head.

The subwoofer is impressive and it's equally as compact as the tweeters.

But don't let its size fool you — the level of bass output is simply astronomical. There's a small dial located at the back of the device to adjust bass levels from 1 to 11; however, in our testing, we found that keeping it at the absolute minimum setting was perfect.

Setup is relatively painless. There's an optical input for HD TVs, RCA-to-analogue input for your system and to connect the speakers to the sub, and that's about it. If your phone has NFC, you can pair the T4 up to the device wirelessly.

An annoying thing to note is that power-saving mode kicks in after 20 minutes of inactivity, turning off the system. That aside, Creative really has nailed it here.

■ Zak Storey

Verdict

Great sound quality; stylish; simple setup; versatile; cost-effective; compact.





LIVE-STREAMING CAPTURE CARD

\$240 | WWW.RAZERZONE.COM

Razer Ripsaw

Game capture the easy way.

We love watching live-streaming here at APC: not a day goes by without one of us casually watching a *No Man's Sky* stream on Twitch. It's growing at a phenomenal rate. As more and more of us tune in to watch our favourite live-streamers, it's only right that the number of live-streamers increases as well, right?

It's never been an easy feat to get up and running. For those looking to get into streaming, it's previously been an arduously complex setup process. You need the right system, preferably with a Core i7, peripherals, an appropriate GPU and, of course, enough bandwidth to catapult those 1.8 million pixels you're pumping out. That's not even taking into account the software side of things, such as OBS and XSplit.

It doesn't need to be that complicated. Each of us has a voice, and each of us wants to be heard – that's the conclusion Razer has

reached, at any rate. Which is why, after two years of development, we have the Razer Ripsaw. It's by no means the first capture device to hit the shelves, but it's one of the few that's targeted at providing a solution for the gamer who wants to record from anything to everything. Fancy streaming from your old GameCube or N64? You can do that with the component adaptor that's included. How about from your PC to another PC? Sure.

Now, we know many of you will be sitting there thinking, "What's the point? I already have a powerful enough PC to do that." Well, yes, that might be the case, but the beauty of the Ripsaw is that you can plug and play straight from one rig into another. You leave the idle system to render and stream the footage (or locally record it, whatever's your jam), and then have access to the entirety of your main rig's processing power solely for gaming. Think of it as what ShadowPlay originally did

for GeForce, but far more advanced.

Setup is fairly painless. You simply plug an HDMI cable from your gaming system's graphics card into the Ripsaw, then an included secondary HDMI cable from the Ripsaw to your monitor. A USB cable goes from the Ripsaw to your streaming system, and job done. There are some fancy mixing features you can utilise at the front of the Ripsaw, but that's about it. Then it's just a case of downloading and installing Synapse on your streaming system, and you're good to go to use it as a video capture card.

During our time testing it, we found the Ripsaw wonderfully consistent. The local recordings were crisp and sharp – 60fps was a doddle. Fortunately for us, our gaming system comprised an Intel Core i5-4670K and a GTX 970, while the streaming system held at its heart a Core i7-6700K and 32GB of DDR4. Admittedly, that's probably not your average use

scenario, but even an Intel Core i3 should be more than capable of streaming 1080p at 60fps, bandwidth permitting, of course.

Ultimately, using the Ripsaw makes for a surprisingly enjoyable experience. There were limitations in use, but they were mostly due to Twitch's delays. Being stuck having to use HDMI wasn't ideal, and having access to higher resolutions would also have been nice (1080p is your limit). While 1440p or 4K isn't easily accessible for the majority, having the option would have been a great way of future-proofing the Ripsaw. ■ Zak Storey

Verdict

Features
Performance
Value

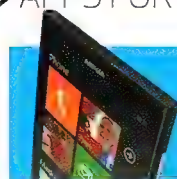


Offers great versatility and features at an affordable price, but no option for capture above 1080p is disappointing.



software

» APPS FOR ALL THE PLATFORMS



Windows Store » WINPHONE

Viber

Internet calling re-vibed.

FREE | WWW.VIBER.COM



After being in beta on the Windows Phone platform for a month or so, the well-established internet voice-calling app Viber has finally shed its training wheels and progressed to a full Windows 10 for Mobile app.

The update brings with it a number of big improvements, including a video calling feature, that's better than what was already decent in the beta version. Apart from a quirky public chat area (which allows you to follow threads of user-generated content on obscure topics) the Viber app is pretty slick, with just a message area, contacts area and a dial pad tab. Additional perks include a quick reply option that'll allow you to respond to an incoming message without closing the app you're currently in, full Cortana integration so you can dictate messages, and new sharing options that'll let you flick people videos, links and locations easily. This app is a great addition to the Windows 10 for Mobile range.

Joel Burgess

Search or start new chat

J

1 2 3
4 5 6
7 8 9
* 0 #



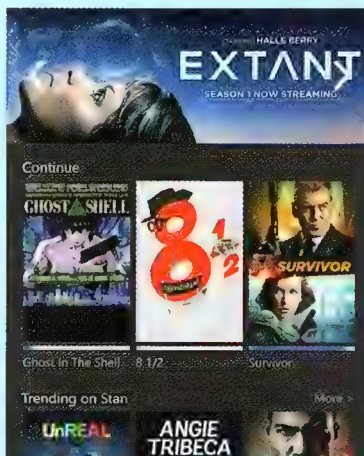
Stan

SUBSCRIPTION \$10 PER MONTH
WWW.STAN.COM.AU



Nine Entertainment and Fairfax Media's Aussie video streaming-service lovechild Stan has made some decent progress since its launch in 2015, snatching up a solid number of Australia's streaming aficionados. Arguably one of the main reasons behind the success of this TV and movie streamer is the effort the local players have put into developing apps for lots of platforms. To that end, the company has finally made it round to finishing off its Windows Phone offering — and to be honest, it's rather excellent. Keeping the layout of the service's other applications, your partially-watched titles will appear in a horizontal bar just beneath the banner carousel, which features all the noteworthy promotional titles and continues into the trending and category segments. Once you've selected a title, the playback interface is relatively clean, but still allows you easy access to the necessary controls and a useful selection of video quality settings. You'll need a subscription to actually access the app's content, and if you're watching while commuting, you might want to look at increasing the capacity of your monthly data allowance, but barring those caveats, this is a well-designed and constructed streaming app.

Joel Burgess



Steam

FREE | STORE.STEAMPOWERED.COM/MOBILE



Valve's extremely popular PC game distribution platform Steam has been available on Windows for well over a decade now, but it's only just been dragged (kicking and screaming) onto the Windows Phone platform. Valve actually copped some backlash last year after it started promoting two-factor authentication on phones when it didn't yet have a Windows 10 for Mobile application. Well, it took nine months, but an app has landed — and actually looks as good as the offerings on iOS or Android. In addition to dedicated Steam Guard and transaction confirmation sections, the new app lets you access Steam's Chat, Store and Community features (ie. what you'll find on the PC interface). We experienced a couple of glitches when trying to watch video previews of games, but didn't bump into any other blunders, so for an app that skipped beta, we're actually reasonably impressed with how well it runs. For anyone with a decent collection of Steam games, it'll be a massive relief to see this app finally on the Windows Mobile platform, and the fact that it's as feature-rich as the iOS and Android versions is icing on the cake.

Joel Burgess





Mac » APPS

CameraBag Cinema

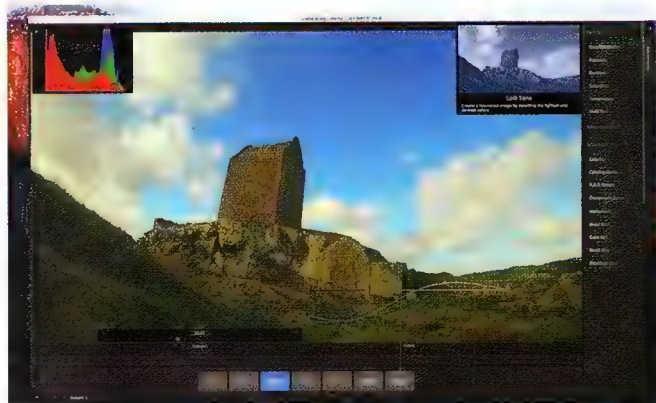
A powerful video-grading tool.

\$119.99 | NEVERCENTER.COM



Video grading isn't usually for the faint-hearted. The process of adjusting the colour and tone of your footage can be a daunting concept that many keen movie makers don't have the confidence to dabble with. Camerabag Cinema makes the process incredibly user-friendly. Place the pointer over a thumbnail to cycle through examples of what each of this app's tools can do to your clips. Tools can be combined in a modular fashion for a range of results and presets help you get going with instant effects.

The presets also help you mimic the colours and tones produced by analogue film stock, with a number of added artefacts such as vignetted edges and film grain. The added level of adjustment to these creates a more realistic filmic style than you can get using iMovie's rather limited presets.



One of the app's most powerful features is its ability to adjust tones and colours using curves. After adding a curve preset to create a flat contrast (which helps you see detail in the shadows and highlights), you're able to drag points on the curve to adjust shadow and highlight levels separately. The clean interface means you can alter your clip's look without being distracted by panels. Nevercenter advises having 4GB of memory, but more is better, as rendering can take a while. On an iMac with 24GB of memory it took just over five minutes to render a 13-second, 4K clip. This is an invaluable addition to any video editor's toolset. **George Cairns**

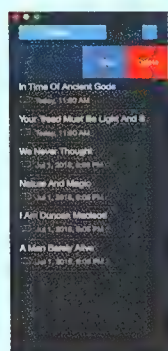
Notea

\$6.99 | INSPIRINGLIFE.CO/NOTEA



Notea is a no-frills Mac application that trackpad users will love. It offers little in the way of user interface, aside from a list pane at left from which writers can create notes, search text or organise existing notes into folders. Once you start typing, this pane slides out of sight. The first line of text entered automatically becomes the document title formatted with larger bold text, while anything written after the first line break becomes the body. A popup contains options to increase or decrease text size, switch between light and dark modes or choose fonts.

This lends itself perfectly to fullscreen mode. Writers can pinch to change font size, swipe to show or hide a list, and share or delete individual notes. Existing notes can be synced to all your iOS devices with a companion app. And that's pretty much it. Those needing something with rich text formatting or looking to escape Evernote are better off sticking with Apple Notes instead. **JR Bookwalter**



You unlock this door

With the key of imagination. Beyond it is another dimension: a dimension of sound, a dimension of sight, a dimension of mind. You're moving into a land of both shadow and substance, of things and ideas; you've just crossed over into the Protected area.

In the criminal justice system, the people are represented by three

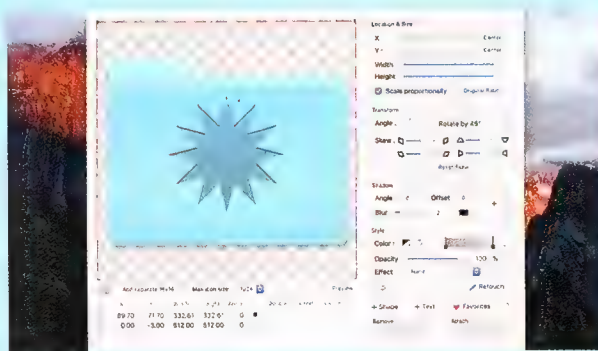
iconStiX

\$13.99 | TROLLIN.LOOS.LI/ICONSTIX



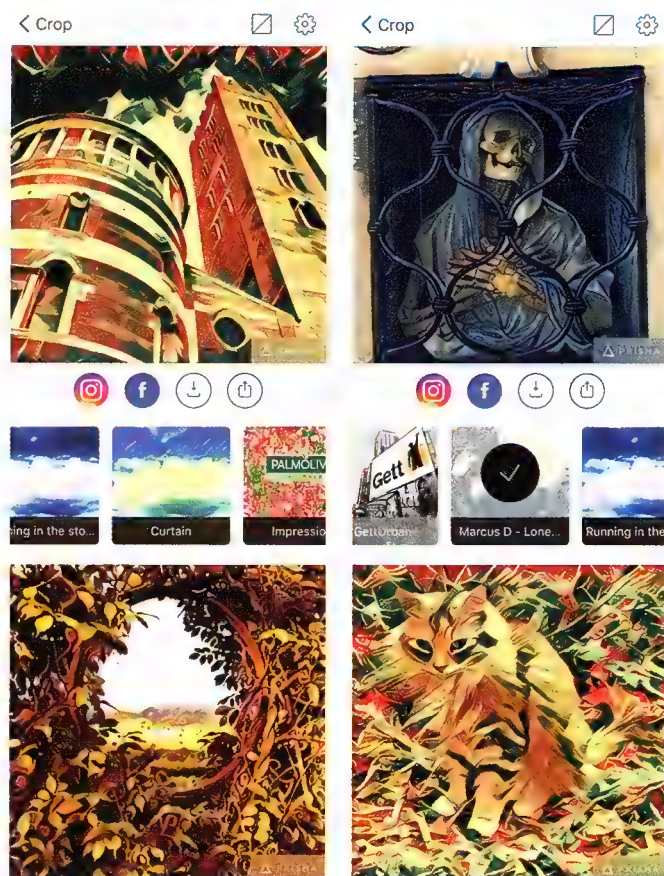
iconStiX aims to bring individuality to your desktop, by way of adding text, images and shapes to icons. Drag items from Finder or select objects from a Favorites window. Granted, the likes of Image2icon offer much the same (and, in that case, in a more friendly design), but what puts iconStiX into the recommendation pile is its flexibility. There's support for multiple layers and objects. You can adjust any item's position, skew, angle, shadow and style, along with its sort order in the stack. Text can be integrated, and photos cropped. Output can be previewed at various sizes in the edit window, which usefully temporarily displays a Mac desktop image.

iconStiX might be lacking in immediacy and polish, but it more than makes up for that with versatility, and in offering scope for creativity. It's not as straightforward as Image2icon, but it rewards with smartly conceived features. **Craig Grannell**





App Store » iOS APPS



Prisma

Turn any photo into art.

FREE | PRISMA-AI.COM

△ This particular reviewer doesn't really 'get' the appeal of filters in the style of Instagram and Snapchat. But Prisma is different – miles different. There are no dog tongues or rainbows, '70s cop moustaches or pandas, bread faces or flower crowns to be seen here. Instead, the filters are based on the works and styles of famous and talented artists.

Want to give your group photo a touch of Picasso? Done. Curious as to how Katsushika Hokusai may have captured that view? One tap later, instant masterpiece. Each filter lends a different style to your image of choice, but not every style works for every picture. 'Femme', for example, works best on faces, 'Red head' excels in urban environments and 'Coloured sky' is best used with simple photo subjects. New styles pop up every other day, too, so there's always a reason to come back. From Impressionist to sketchy, water colours to digital cartoon, Prisma can become very addictive very quickly. Take note, though, that constant use is going to make your phone rather warm. It's easy to share your creations to your social media of choice, as well, but this particular reviewer is happy to simply look at her fur baby the way Van Gogh may have done.

Carmel Sealey

Block and Flow

FREE | TINYURL.COM/APC433-BLOCK



Productivity tools are fairly common these days, thanks to how easily they can be used via a mobile device, and also how distracted we've all become (no thanks to YouTube). While some of us might be disciplined enough to simply say, "Just get back to work, you numpty!" to ourselves, others need that little helping hand. Block and Flow is a 'Pomodoro' time management app, where you're encouraged to break your day up into blocks, designate each block to accomplishing or working at a certain task and concentrate on that one thing for a certain amount of time. Using the app is simple, thanks to its clean and self-explanatory UI. Create categories (such as study, exercise, work, research, testing, writing, chores and so on) and colour-code them. Your block is a 25-minute time period. Stay focused for that long and you achieve a block. Knowing you've kept your focus for that long is strangely satisfying, and keeping to your schedule is greatly rewarding.

Writing



★ ★ ★
INCREDIBLE

Text Expander + Keyboard

FROM US\$40 PER YEAR | TEXTEXPANDER.COM



In the latest update, the focus has been on what's missing rather than what's new. SmileOnMyMac now has its own cloud-based syncing platform for TextExpander, which replaces the use of Dropbox and iCloud, and enables group sharing of snippets. The subscription model costs about US\$40 a year, with an upgrade price of \$20 for existing customers. (Version 3 remains for people who want to stick with other cloud services for syncing or don't want subscription software.)

TextExpander installs as a third-party keyboard in iOS and offers improved autocorrection, frequently used text, dates, emoji and phrases, formatted text and code blocks. Many big-name apps support it directly, and the TextExpander keyboard covers the apps it doesn't integrate with. But you can say the same about the old version, too... so is the new app better than the old one? For individual TextExpander users, rather than businesses who'll like group syncing, currently no. It's a powerful text tool, for sure, but the pricing is an issue.

Gary Marshall

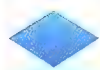


Google Play » ANDROID

Dropbox Paper

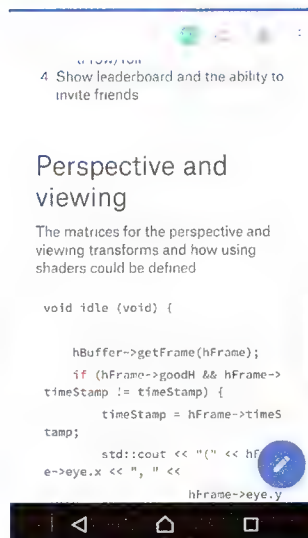
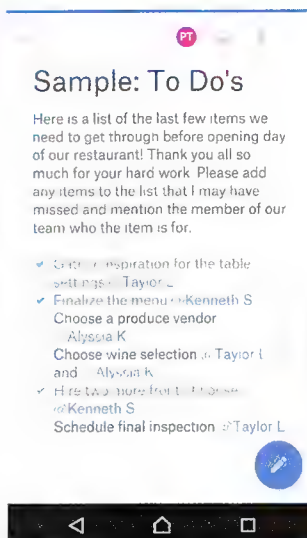
Taking on Google Drive.

FREE | PAPER.DROPBOX.COM



Until now, Google Drive and its suite of Microsoft Office-like tools has been the go-to collaborative creation. While Dropbox Paper does a lot of what Drive accomplishes, it's more than an alternative, it's a genuinely impressive package for building presentations, spreadsheets, documents and even compiling code.

The power comes from how simple it is to format the document you're working on, and being able to tag your collaborators, whether you're asking for feedback on an idea or assigning tasks. The app's a paired-back version of the far more comprehensive desktop version — you'll need to turn to the latter to add in tables, code boxes and better commenting tools — but you're still free to add images, links to videos and websites, and more on the fly. Right now, Paper is still in a



beta stage on Android, but what we've seen is very pleasing. If you love Google Docs, Sheets and so on, Paper might be enough to make switch over to the rival cloud storage service; you will need a regular Dropbox account to be able to use it, though. **Paul Taylor**

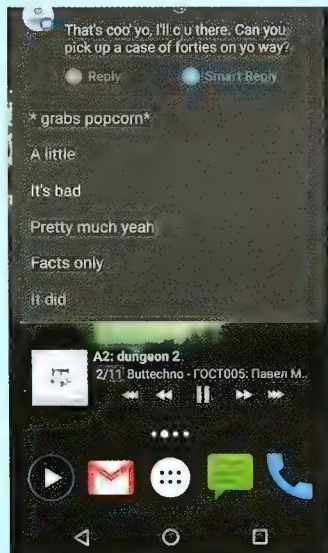
Fluently

FREE | FLUENTY.CO



Sending text messages can be a huge pain in the bum, especially when you're expected to answer quickly and coherently. Fluently theoretically makes that easier: for every received text message, it adds a dropdown box with a list of possible responses, ranging from the quick (yes, no, not sure) to the vaguely poetic (yes ma'am lol, *grabs popcorn*, facts only). But if none of the dropdown options appeal, you can always dictate a message with the press of a button, or send one in the good old fashioned manual way. It's a super easy

tool to use, and it's amusing how Fluently will often prioritise the more personable/charismatic responses over the functional ones, making you sound like some lame millennial AI. If you're in the habit of sending similar messages regularly, the app will remember and offer these in the menu for future conversations. Overall, this is a clever app, and well integrated into both the iOS and Android operating systems. **Shaun Prescott**



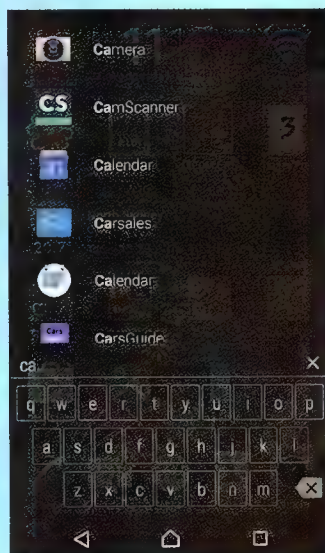
Sesame Edge

FREE WITH IAP | TINYURL.COM/APC433-SESAME



Perform an action long enough and your thumbs will twitch involuntarily through the motion without real conscious effort — but how much time could you save if you actually thought about it? Sesame Edge wants to break that muscle memory and offer a powerful way to reach shortcuts and not only for your most-used apps, but for your most searched-for shows, music and searches across all your apps. As you use your phone, Sesame Edge learns what you look for and use most frequently — and not in the creepy way. Open

Sesame (on the lower right-hand edge of your screen) and shortcuts to your 10 most-used apps are immediately presented. Start typing and Sesame's search function rifles through your contacts and apps to return what it thinks you're looking for. It works, but it has a way to go yet: the description screen says the app will search for Netflix shows, too, as well as Spotify tracks and even Reddit posts. These functions, unfortunately, refused to work in our test. However, it's looking promising. **Paul Taylor**





Geek Uninstaller

Remove all traces of even the most stubborn unwanted programs.

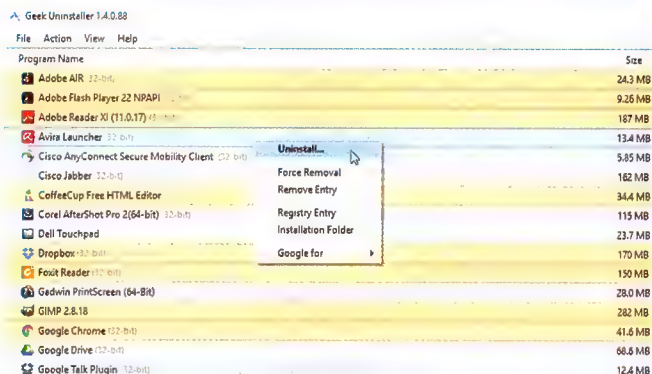
FREE | TINYURL.COM/APC433-GUNIN



Most programs come with their own uninstallers, but these often don't do a particularly thorough job, leaving superfluous registry entries and system files in their wake.

Antivirus programs are particularly notorious for leaving mucky footprints behind in the form of temporary files and small programs, which can cause software conflicts when you try to install another tool later. GeekUninstaller is completely free, and doesn't need to be installed — just save the EXE file to a USB stick, then double-click to run it on any PC that needs a good scouring.

Run GeekUninstaller and it'll perform an instant scan of your system, displaying a list of all the programs currently installed. The ones installed most recently are highlighted in orange, which is a thoughtful touch (if you're in a hurry to remove something, it's probably only appeared recently). You can also search for a program by name.



When you've found the program to evict, right-click it and choose how to remove it. The standard option uses the program's own uninstaller, after which GeekUninstaller will sweep your system for leftover files and registry entries.

For particularly tough programs, or ones with broken uninstallers that throw up errors about missing components, the Force Uninstall tool performs a deep scan, then mops up every trace.

Other uninstallers include extra bells and whistles like drive cleaners and file shredders (tasks often performed better by a dedicated tool like CCleaner), but GeekUninstaller is a master of one trade and a jack of none. The only drawback is that you can't use it to remove pre-installed Windows 10 apps, but it's superb for cleaning up after downloaded software.

Cat Ellis

Paint.NET

There's no need to spend money on expensive software to look your best.

FREE | TINYURL.COM/APC433-PNET



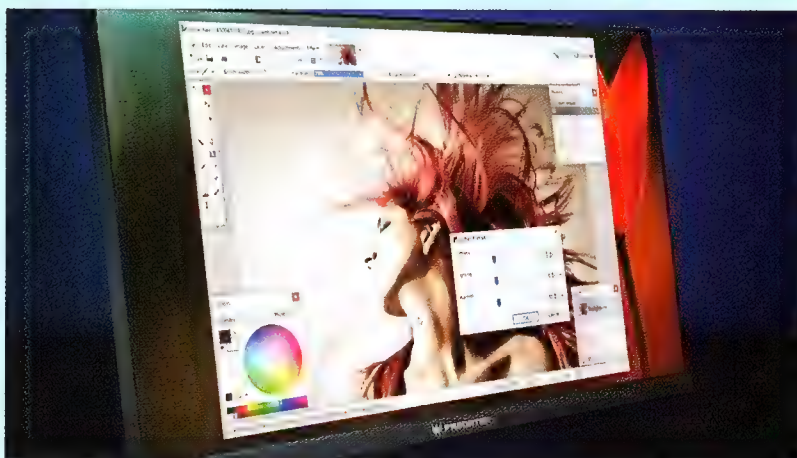
Photo retouching may colloquially be referred to as 'Photoshopping' but you don't actually need to splash out on Adobe's premium (and rather clunky) software to make your pics look stunning.

Paint.NET is a completely free photo editor that's just as capable as many full-price programs. It was originally created as an upgrade/replacement for Microsoft Paint, but has evolved from those humble beginnings into a powerful tool for editing images and creating your own artwork from scratch.

Editing out blemishes is easy with the stamp tool — hold Control and click a nearby area to take a sample, then click and drag to 'paint' over the flaw. Like all the tools in Paint.NET, the stamp is fully configurable and can be adjusted using the options at the top of the main window.

Paint.NET also supports plugins and one of the best for photo retouching is Liquify, which you can download from the official forums (forums.getpaint.net). Just like the Photoshop tool of the same name, it lets you distort images by clicking and dragging.

Like any photo editor worth its salt, Paint.NET includes



a levels editor (under Adjustments), which you can use to adjust the contrast in your image. Tweaking the diagonal line into a gentle S shape will increase contrast and make your picture look more dramatic, but you might find decreasing the contrast yields a more flattering effect.

With a generous offering of dedicated functions and filters, plus user-created plugins that replicate the most popular features of premium retouching tools, Paint.NET is an essential program for tweaking everything from selfies to wedding portraits — and it's completely free.

Cat Ellis



Linux » OPEN SOURCE SOFTWARE

Gimp

A feature-rich editor.

FREE | WWW.GIMP.ORG

Image-editing suite Gimp was one of the first bold and feature-rich graphical Linux applications, and its interface library grew into the core part of many desktop environments, such as Gnome and Cinnamon.

Gimp doesn't often supply new and fresh releases, but when it does, the list of changes is always thrilling and amazing. The 2.9.4 version is a major milestone and a significant leap forward since the 2.9.2 release. The first thing you'll notice is the new tool icons – they are now monochrome and come in vector format (you need to enable this in the build configure options). The overall look is now much more like Photoshop. It was possible to achieve similar results with Gimp 2.8 (see bit.ly/1qSUKbT), but the new Gimp 2.9.4 is designed to look this way from the start and you don't have to tweak anything.

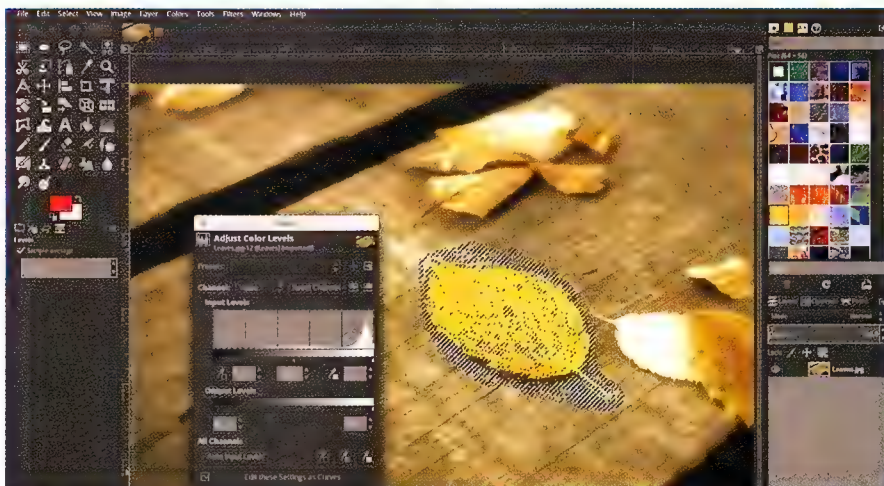
There's more good news. The now built-in colour management feature doesn't depend on LittleCMS anymore, and there's support for MyPaint brushes, symmetric painting mode, and more filters using the new GEGL engine, with a modern split preview for GEGL-enabled filters (move the curtain to compare 'before' and 'after'). There's Darktable integration for importing RAW images, a revamped screenshot-taking tool, as well as enhancements for selection tools and new shortcuts.

Also, Gimp can now handle batch commands without scripting or third-party modules like this:

```
$ gimp -i -b '(with-files "*.png"(gimp-file-save 1 image layer (string-append basename ".jpg") (string-append basename ".jpg")))(gimp-quit 0))'
```

This command converts all PNG files in the current directory to JPEG. You can enhance this macro to use more of Gimp's power, such as inverting, rotating images and applying effects.

To get the newest Gimp release, use bleeding-edge or rolling-release Linux distros or use the Ubuntu PPA at ppa:otto-kesselgulasch/gimp-edge.
Alexander Tolstoy

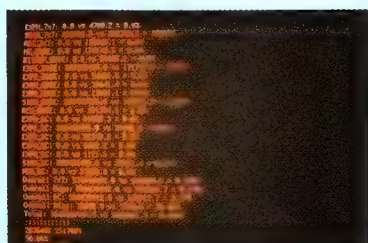


Ghetto-Skype

FREE | BIT.LY/GHETTOSKYPE

The last update of Skype for Linux came out in 2014, raising concerns about whether Microsoft will keep updating the software for Linux at all. Ghetto-Skype is an unofficial Skype client that has many parts in common with the official Microsoft Skype for Linux Alpha, but here, we have the code and can be sure that the app is safe. Ghetto-Skype uses the same connection as web-based Skype but also uses the benefits of Electron more efficiently. You get a tray icon with native desktop notifications, good integration with your desktop accessories and a working proxy detection. You can make audio calls, but no video calls yet. This isn't the fault of Ghetto-Skype, but rather the downside of the web version of Skype. All the rest works well and is quite responsive.

You can get Ghetto-Skype sources and build it on your local machine with `$ npm install && npm start` in the application's directory. The project website also has DEB and RPM binary packages for other Linux users.
Alexander Tolstoy



Cumulus

FREE | BIT.LY/CUMULUSAPP

The number of apps dedicated to displaying the current weather can hardly be counted. A few years ago, the Ubuntu Software Center featured Stormcloud, a weather app that featured nice desktop integration. Yahoo Weather, the data provider, then changed its API and Stormcloud became useless. Later, it was resurrected as the open-source Typhoon, but this was soon abandoned as well. Now we have Cumulus which is nearly identical to the original Stormcloud app, still powered by Yahoo Weather.

Cumulus is a set of Python scripts with GTK bindings, a fixed size and modern flat design. In several desktop environments, including Unity, Pantheon and Gnome, Cumulus will show the interactive launcher icon with the current temperature in the small balloon, but we've found it to be perfectly useful on any desktop.

Currently, the project's website offers the tarball with sources and the Deb package, so if you're not on Ubuntu or any of its relatives, you'll need to install the application manually. Alexander Tolstoy



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VIRTUAL REVOLUTION HANDBOOK

EVERYTHING YOU NEED TO KNOW TO GET
STARTED WITH VR ON YOUR PC

Virtual reality is the next great frontier in computing — and for now, the best experiences all require a reasonably powerful desktop system. This month, we've delved deep into the world of VR to put together this huge guide that covers all the basics — and then some. From which VR headset to buy, to building a rig for VR from scratch or upgrading your existing system with a new graphics card, alongside what to play and even the future of VR, we've got you covered.

And if you're just interested in dipping your toes into VR, we've looked at that too with our smartphone-VR quickstart guide. Read on to learn everything you need to know.

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The full HTC Vive kit includes plenty of goodies.



VR headset buyer's guide: Vive vs Rift

Welcome to Day One of the Virtual Revolution.

The first hour of this revolution took place over 30 years ago, when people like those at NASA started experimenting with the concept of Head Mounted Displays (HMDs). By strapping a small screen to each eye, and monitoring the movement of the user's head, computer scientists were able to bring the user into the 3D virtual world, rather than peer at it through a static 2D window. Sadly, the hardware just wasn't capable, and then the '90s hit. Inspired by films like *The Lawnmower Man*, for a couple of years, VR arcades were all the rage, and yet the hardware still couldn't deliver the razor-sharp resolution and incredible performance that VR demands. Punters would pay \$20 for a 15-minute session that left them nauseated, frustrated... and yet intrigued by the idea of working VR.

Fast forward to 2016 and we have not one, but two, working, comfortable, consumer VR kits on sale. Kicked off by a young kid called Palmer Luckey's discovery that smartphone screens and special lenses combined to make VR both affordable and comfortable, we've now got the Oculus Rift Consumer Version 1 (CV1) and HTC Vive both competing for your VR dollars. They're both amazing in their own way, but each also has their weaknesses. We have to emphasise that they're not perfect. This is generation one of workable consumer

VR, and it's got a long way to go before it truly captures the perfect look and feel of the real world. This is early adopter gear, built for those who want to experience the future before it's quite ready.

With that said, let's take a look at how these two kits differ.

HMD COMPARISON

Looking at the specifications, and it appears as if both HMDs are almost identical. They both have an identical screen resolution of 2,160 x 1,200, which is split down the middle to deliver 1,080 x 1,200 per eye. Both screens refresh at a whopping 90Hz, which is crucial to the VR experience — dip below this and simulator sickness becomes a real issue. This is why it's paramount to have a PC that has the horsepower to deliver this resolution at 90 frames per second, but more about that later. Both HMDs have Interpupillary distance adjustments, so you can slightly adjust the distance between each screen to better match your eye position.

The Vive weighs in at 555 grams, while the Rift is slightly lighter at 470 grams. It may not sound like much, but the ergonomics of each HMD makes a profound difference. We found the Rift to be far more comfortable for several reasons. Firstly, it's not so face heavy, while the rear strap makes feel more centralised on the user's head.

Secondly, there's a tiny gap at the bottom of the Rift that lets in air. The Vive is totally sealed, so any sweat from the user can cause the lenses to fog, especially in more rigorous activities. Finally, the Rift is much easier to put on. The mounting straps extend by about an inch as you put it on, making it much easier to put in place, especially if you wear glasses. Having said that, we spent five hours non-stop in the Vive without any neck-strain or pain, but the Rift is definitely the comfier of the two.

When it comes to the all important image quality, the two are quite closely placed. Despite both claiming a 110-degree field of view, the Vive definitely feels a little wider. On the flipside, this makes the pixel structure and pixels slightly more visible on the Vive. To be frank, they both need huge increases in pixel density to deliver razor-sharp images, and this is most apparent in games where you need to see high detail or long distances. The screen resolution may sound very high, but it's worth bearing in mind that the user is viewing these at a distance of an inch or two, through magnification lenses. It's going to take massive screen densities to match real life — we're talking 40K to 80K, which is a long way into the future.

Today's screens are fine if the experience is designed for it. Games with relatively low detail and close-range scenes look fine, and the ability to be inside them more than makes up for



In comparison, the Rift only has a handful of items in the box.



the perception of pixels. There's also another issue that the community has called God Rays – light objects on dark backgrounds emit a strange halo effect as a result of the special lenses used in these headsets. Again, it can be mitigated by clever game design (don't put a white box on a black background).

Overall, we'd say image quality is a tie – the Vive has a slightly wider, brighter field of view, while the Rift's pixels are slightly less obvious.

IMMERSION

It's here that the Vive is the big winner. Oculus still hasn't shipped the Touch motion controllers that will allow players to use their hand and arm movements to interact with in-game objects; instead you're lumbered with an Xbox controller. In comparison, the Vive's twin motion controllers make a world of difference. Instead of sitting inside a virtual world but unable to interact with it, it's possible to reach out and grab things, have sword fights, fire virtual bows, and so much more. For this reason, it's wise to have a one-metre gap between your play area and any walls.

We recently got to try out the Rift's Touch controllers, and were impressed at their accuracy. There are also hints

that they will bring room-wide motion with them, so time will tell if the Rift can catch up in this area. But until then, when it comes to being inside the virtual world and interacting with it, there's simply no competition – the Vive wins hands down. Or should that be hands-up?

THE BIG PICTURE

With both kits currently costing over \$1,100 for Aussies, it's obvious that the Vive is the more comprehensive package. Our dream kit would be the Rift headset with the Vive's extras, but that's not to be. Things are far from said and done, though, with the launch of the Oculus Touch controller in a few short months. There's no word yet on pricing, but we're guessing they'll add up to make the Rift a more expensive proposition.

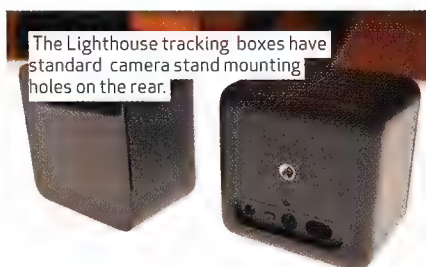
You also need to remember the PC requirements behind both kits – both need a GTX 970/R9 290 equivalent GPU, as well as a Core i5-4590/AMD FX 8350 or better. Thankfully, AMD has come to the rescue with its \$400 Radeon RX 480 card, but we've got concerns about that which we'll get to later.

Regardless, jumping into the VR revolution is neither cheap nor

convenient, but it is truly breathtaking once you've experienced it. There are still obvious issues, and games not designed for VR highlight these. However, once you've played some of the better quality VR games on the market, you'll be convinced that this is the future of entertainment – we're just not sure how long it's going to take to become the affordable, perfect service that the mainstream market wants. By our best guess, we're thinking three to five years at least.

GETTING SET UP

It's here that we come to the real difference between the two kits – the Rift is currently designed to be a stationary seated or standing experience, while the Vive is meant for room-scale play. Thanks to the use of two tracking boxes, called lighthouses, a minimum play area of 2m x 1.5m is required, but it will scale up to a room with a diagonal width of 5m. Having to install these tracking boxes is a little painful, as they have to be at ceiling height and each have their own power supply. Thankfully, Vive include permanent mounts that can be mounted to your walls, but you'll need to drill holes if you want to use these. Also, if



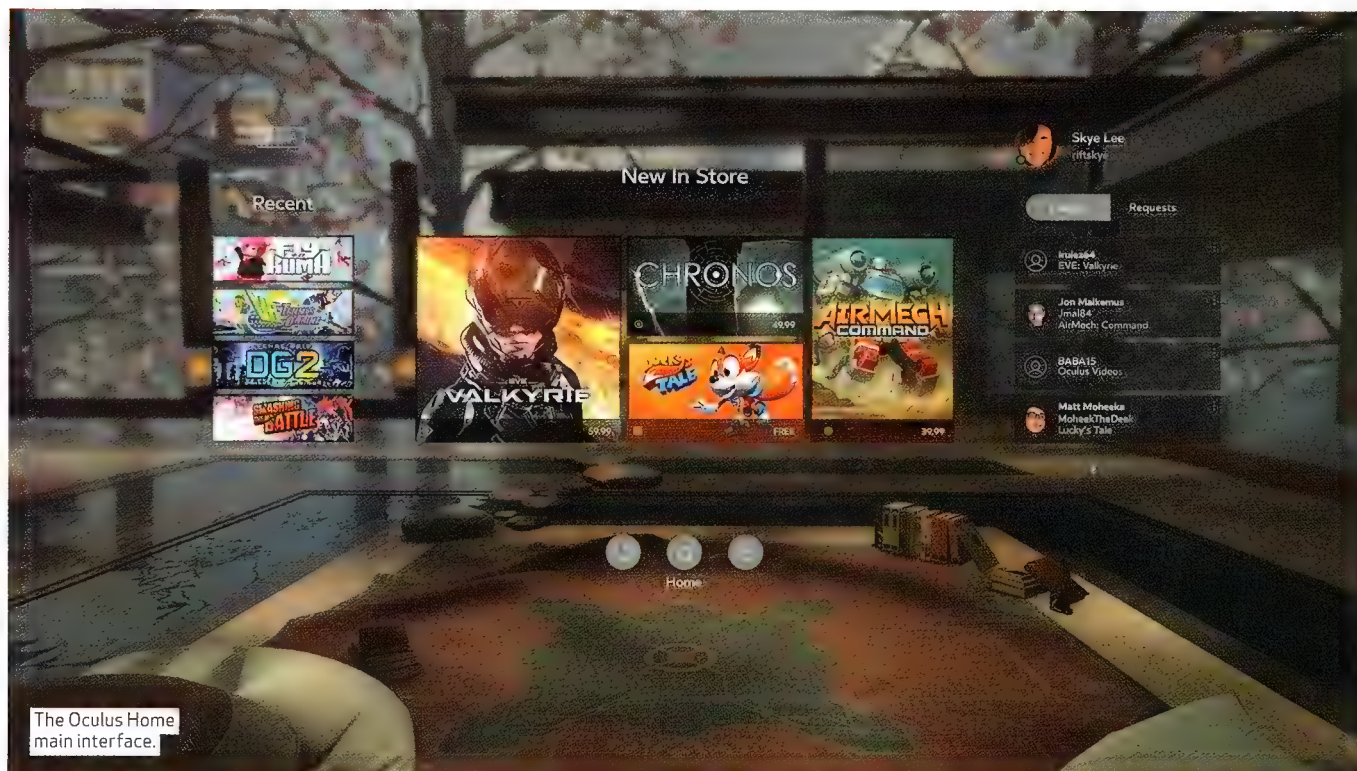
The Lighthouse tracking boxes have standard camera stand mounting holes on the rear.



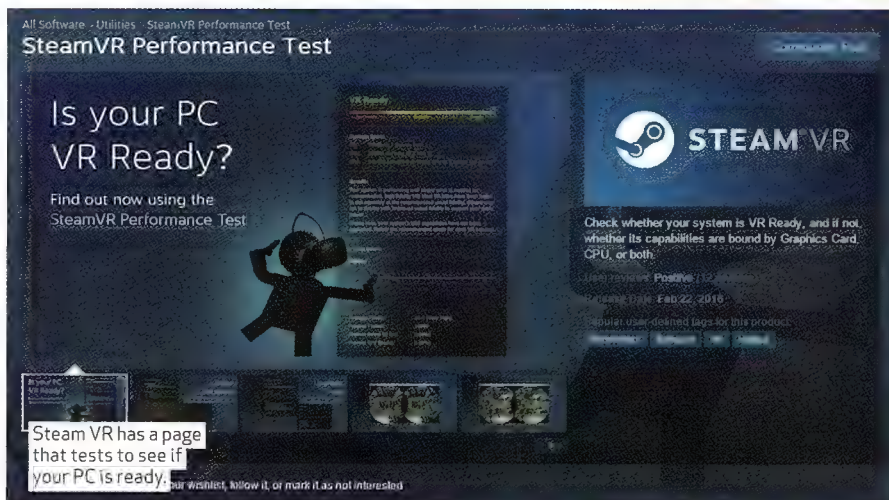
Here's a close-up of the Vive's permanent wall mount.



The Oculus remote is designed for very simple VR experiences.



The Oculus Home main interface.



Steam VR has a page that tests to see if your PC is ready.

A camera stand is an easy way to temporarily mount the Vive's Lighthouse tracking boxes.



there's an object blocking the view between the tracking boxes (like a light fitting), you'll need to use a special cable that connects the two boxes.

An easier solution is to use camera or light stands, as the lightboxes have camera mounts on the rear. You can pick a couple of these up for about \$100 each, and they're far simpler to dismount when the Vive is not in use. Just make sure they're nice and tall, reaching near ceiling height.

In comparison, the Rift has a small camera that sits on your desk and takes approximately two minutes to set up. It's really not a fair comparison, though, as the Vive's room-wide experience really does enhance the overall immersion, so the extra time put in to setting it up is worth it.

As for software, the Vive uses Steam, which has a special VR mode. It basically presents the steam store as a

giant wall, and you can then use the motion controllers to navigate. Oculus has its own proprietary Oculus Store, which is an 840GB download, without games. Putting the headset on automatically fires this up, placing you in a virtual mansion with a hovering wall of games in front of you, much like the Steam interface. They're basically identical in terms of ease of use.

SETUP TIPS AND TRICKS

When setting up the Vive's play space, ensure you have at least a metre gap between the edge of the play space and any walls. You'll be swinging those controllers around a lot, and that gap will save many broken controllers, as well as grazed and bruised knuckles. Also, the Vive's tether can get tangled very easy – a simple solution is to mount a rotating hook in your ceiling, and hang it from there, though this will

decrease the available length of the tether. We found with practice that we naturally learnt where the tether was, so didn't trip over it too much.

The Rift doesn't require too many tricks, but there is a way to enable semi-room support. Due to the way the camera works, a trapezoid extends out from the camera, enabling movement in a space around 2 metres wide. However, you'll need to stand further away from the camera – stand too close and you'll be cut off from the edges of the cone of tracking.

Unfortunately, the Rift currently only supports installing the Oculus store and games to your primary drive, which is probably full already. To get around this, you can use symbolic links to point to another hard drive – a quick Google search will reveal how this is done. ■

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DIY virtual reality headset?

Lindsay Handmer asks: Is the Open Source VR project a viable option in Australia?

VR hardware such as the HTC Vive and Oculus Rift are fantastic, but also rather expensive. Worse, some games are exclusive to a single platform, or are delayed coming to one over the other. To combat this problem, OSVR wants all the games to work with all the VR headsets and controllers, and is open source. By creating an open, universal standard, the OSVR project hopes to make it easy for gamers to just play what they want, no matter what brand of system they buy.

The project has two parts – open-source software to allow games to talk to the headsets, and open-source hardware, in the form of a head-mounted display (HMD). Importantly, the OSVR HMDs are currently more affordable than the competition, though are currently aimed at developers, rather than end users. While OSVR is supported by many companies, the OSVR headset development is being done by Razer and Sensics. Razer has announced a US\$5 million development fund to help entice OSVR support. There are also over 320 other companies involved in OSVR, from dedicated partners such as Sensics and Leap Motion, and other big names like Intel, Ubisoft, Valve and Nvidia. OSVR will run on Windows, Linux, Android and OS X. Check out more info at OSVR.org.

HEAD MOUNTED DISPLAYS

The OSVR hardware comes in two models – the older HDK1 and the newer but more expensive HDK2. At this stage both are sold as Hacker Development kits, but are available for anyone to buy and use. The US\$299 HDK1 (~\$400) uses a 5.5-inch 401ppi OLED screen, with a 1,920 x 1,080 resolution, or 960 x 1,080 per eye. It has a 60Hz refresh rate, 100-degree FOV and six degrees of tracking freedom. The US\$399 HDK2 (~\$530) pumps the specs up to a 2,160 x 1,200 (1,080 x 1,200 per eye) resolution, using a 441ppi 5.5-inch OLED screen. It has a 90Hz refresh rate, 110-degree FOV and tracks six degrees of freedom. The HDK2 HMD also has thicker padding and a more comfortable design. The HDK2 kit has comparable specs to the Rift and Vive, and gives a similar

experience. Both units use an array of IR LEDs on the HMD and an IR camera for tracking. The optics are individually adjustable for each eye, as well. Interestingly, the lenses and screen are technically able to be replaced, and there is a US\$220 (\$290) upgrade kit that turns the HDK1 (version 1.3 or higher) into a HDK2. The minimum hardware spec for running the devices is listed as a GeForce GTX 660 or equivalent for the HDK1, and a GTX 970 or better for the HDK2.

OSVR will be supported on other upcoming headsets, such as the Vuzix IWear 720. Razer is also pushing OSVR as the VR platform of choice in China, so it's likely we will see a big range of new, affordable headsets in the future.

MOTION CONTROLLERS

For now, OSVR is compatible with many existing controllers, such as gamepads, steering wheels, joysticks and keyboard and mouse. OSVR uses VRPN (Virtual Reality Peripheral Network), so there are drivers available for loads of existing controllers. For now, there is no official room scale or wand style controllers available, but various OSVR partners have them in development. Currently, the best option for hand tracking is Leap Motion (which is built into the latest OSVR HMDs), and OSVR also supports the no-longer-sold Razer Hydra. Developers have also created support for other tracking options, such as the Kinect, but experimenting with and implementing them goes beyond a plug-and-play setup.

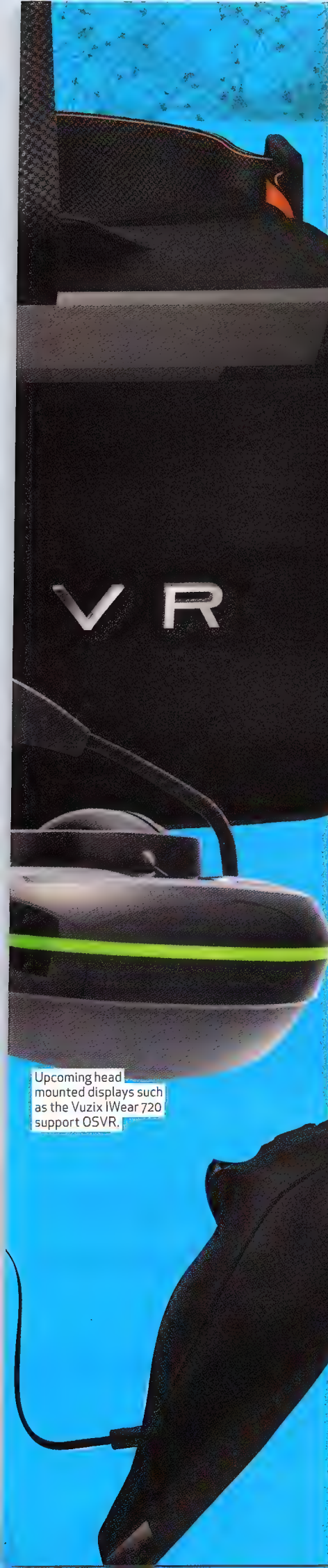
GAMES AND VR EXPERIENCES

OSVR has support from some big names, but still lags behind when it comes to content. Using a manually installed plugin, OSVR works with

The OSVR HDK2 development kit HMD has a 1,080 x 1,200 per eye resolution and 90Hz refresh rate.

OS
VR

Motion controllers such as the Razer Hydra are supported by OSVR, but there isn't yet Vive style room-scale VR available.



SteamVR, and some of the associated library content, such as *Elite Dangerous* and *Project Cars*. There is also a range of other content, such as *Theme Park Studio*, *Epic Games Showdown* demo, *War Thunder*, *Limb* and all sorts of new games made by small developers. The teams behind both Unreal Engine 4.12 and CryEngine have also announced native OSVR support. Ubisoft is a OSVR partner, and while no specific games have been announced, there will likely be some in the future. And, yes, OSVR is also supported by the VirtualRealPorn platform. More content at www.osvr.org/featured.html.

IN AUSTRALIA

Jumping onto the Razer website (razerzone.com/au-en), only the OSVR HDK1 (version 1.4) is listed for sale (AU\$479.95) with free shipping, but it is not actually available to buy just yet. Instead, it's possible to buy the HMDs directly from the OSVR.org website, which redirects to the Razer US store for the actual purchase. The problem is that, while Razer says that shipping to Australia is just fine (AU\$25), the only country options currently selectable are the US and Canada. Razer has stated

that this will be updated soon, but doesn't have a firm timeline on local availability or international shipping. For now, about the only option is using a freight forwarding service, or buying through other sources, such as eBay.

OSVR IN USE

The image quality and tracking of the HDK2 OSVR kit gives a somewhat comparable experience to the Rift and Vive, and is generally very playable. The HDK1 kit is not quite as good, but still provides a reasonable experience, especially on low-end hardware. Despite this, OSVR is still aimed at developers and hackers, and does not provide a plug-and-play setup or use. Those without the ability or inclination to troubleshoot and manually deal with bugs, workarounds, beta drivers and updates breaking existing content should look elsewhere. Even the natively supported content can be fiddly to get running, and there is no guarantee of proper support for different computers. The OSVR HMDs are significantly cheaper than the competition, which does make up for a lot of frustration. OSVR support and playability will only continue to improve, as well.

So is it worth opting for OSVR? If you can deal with getting very hands on with the setup, then OSVR is great for the price. But if you just want to plug in and play, the Vive or Rift is the better solution. ■

Upcoming head mounted displays such as the Vuzix IWear 720 support OSVR.



Thanks to support for SteamVR, OSVR devices can run games such as *Elite Dangerous*.

VR-ready GPUs that won't break the bank

Lindsay Handmer rolls up his sleeves and fires up the test rig to find out which video cards give the best VR bang for buck.

While many VR early adopters already have high-end GPUs, the current range of VR titles are not really that graphically intensive. More affordable mid-range cards can do a decent job, so we put nine options to the test. It's important to note that VR testing is quite different to normal, and high fps results are not the (only) end goal. To create an immersive experience, VR ideally needs to maintain at least 90fps, and not drop many frames. There are various tricks to help out, but the end result is that the quality level varies to maintain the frame rate. This means that a more powerful GPU will be able to maintain a higher average quality level, but the experience itself should be the same.

This is harder to test, so companies such as Futuremark are working on VR-specific benchmarks. At this stage though, the best (and only decent) available test method is the SteamVR benchmarking tool. It measures the average quality level, and gives a score.

It's worth noting that all the cards we tested for this feature managed 'High' detail (but slightly varying scores) with dipping below 90fps, whereas higher-end GPUs can hit 'Very High'. We also tested with a range of synthetic benchmarks and games, to give an idea of overall performance, and these frame rates and scores tend to agree with the VR test.

For gamers on a budget, the other important factor is the hard-to-define, bang for buck. To give a comparison, we calculated how many dollars it cost per fps (lower is better), averaged across all the games we tested. Interestingly enough, this shows that all the cards tested offer a fairly comparable level of value on a per-frame basis.

HOW WE TESTED

We built a custom VR GPU test rig, with over-spec components to make sure the GPU was never bottlenecked during testing. It featured an Intel Core i7-6800K CPU, 32GB of Kingston DDR4 RAM, a 512GB Samsung 950 Pro SSD, ASRock X99 Extreme 6 motherboard, Thermaltake Toughpower DPS G RGB 750W PSU and a Thermaltake Water 3.0 Riing RGB 240 cooler. Games were set at high detail levels. SteamVR benchmarking was used to test VR, as well as manually playing games such as *Elite Dangerous* to check real-world gaming quality.

"To create an immersive experience, VR ideally needs to maintain at least 90fps, and not drop many frames."

GRAPHICS CARD SPECIFICATIONS

	PRICE \$	MAX FREQUENCY	RAM	DIMENSIONS	HDMI	DISPLAYPORT	DVI	POWER
AMD RADEON RX 480s								
ASUS ROG STRIX RX480-8G-GAMING	\$499	1286MHZ	8GB GDDR5	298 X 134 X 40MM	2	2	1	8-PIN
GIGABYTE RADEON RX480	\$449	1266MHZ	8GB GDDR5	250 X 110 X 35MM	1	3		6-PIN
MSI RADEON RX480 GAMING X	\$469	1316MHZ	8GB GDDR5	276 X 140 X 42MM	2	2		8-PIN
AMD RADEON RX 470								
GIGABYTE RADEON RX470	\$379	1230MHZ	4GB GDDR5	250 X 115 X 35MM	1	3	1	8-PIN
NVIDIA GEFORCE GTX 1060s								
ASUS ROG STRIX GTX1060-O6G-GAMING	\$519	1873MHZ	6GB GDDR5	298 X 134 X 40MM	2	2	1	8-PIN
MSI GEFORCE GTX 1060 GAMING X 6G	\$489	1809MHZ	6GB GDDR5	277 X 140 X 39MM	1	2	1	8-PIN
NVIDIA GEFORCE GTX 970s								
ASUS STRIX-GTX970 DC2OC-4GD5	\$419	1253MHZ	4GB GDDR5	280 X 140 X 40MM	1	1	1	8-PIN
GIGABYTE GEFORCE 970 OC EDITION	\$369	1241MHZ	4GB GDDR5	263 X 121 X 36MM	1	3	1	8-PIN
MSI GTX 970 GAMING 4G	\$399	1279MHZ	4GB GDDR5	277 X 140 X 35MM	1	1	2	8-PIN, 6-PIN

RAM: 8GB GDDR5 **OC:** Max 1286 MHz **Form Factor:** Dual slot **Power:** 1 x 8-pin **Ports:** 2 x HDMI, 2 x DisplayPort, DVI

RAM: 8GB GDDR5 **OC:** Max 1316 MHz **Form Factor:** Dual slot **Power:** 1 x 8-pin **Ports:** 2 x HDMI, 2 x DisplayPort

RAM: 8GB GDDR5, **OC:** Max 1266 MHz **Form Factor:** Dual slot **Power:** 1 x 6-pin **Ports:** HDMI, 3 x DisplayPort

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ASUS ROG Strix-RX480-8G-Gaming

Is it worth going for a high-end version?

Using the included gaming software and OC mode, the ASUS RX 480 can be set to buzz along at 1,286 MHz, or have even more performance with further manual tweaking. The card has 8GB of GDDR5 RAM and is kept cool by a chunky RGB LED-lit cooler with triple fans. For easy gaming and VR connections, the Strix RX 480 has dual HDMI and DisplayPort, as well as a handy DVI connector. The card uses a single 8-pin power connector, four GPU controlled fan headers and takes up the usual dual slots. It's worth noting the GPU is 298mm long, so can be a tight squeeze (or in some cases impossible to fit) if you're using a smaller PC case. Performance is excellent, both in VR and out, and this one runs cool and quiet under a heavy load. Its newness means it currently commands a pretty hefty price compared to the other RX 480s. ASUS has lesser non ROG or Strix 480 GPUs, but they lack the same extras, such the larger heatsink and fan control.

Verdict

Great performance, and the slightly higher price is worth it for the extra features.



MSI Radeon RX 480 Gaming X 8G

Factory-overclocked and ready for VR.

The MSI boffins have cranked the core frequency of their RX 480 up to 1,316MHz in OC mode, compared to the stock 1,266MHz. It stays cool with a chunky aftermarket Twin Frozr VI cooler, and can run with the fans stopped at low loads. It also has 8GB of RAM, and dual HDMI and DisplayPort outputs. The MSI RX 480 is a powerful little card, and happily handles the latest games at very playable frame rates. It does its best work at 1080p and 1440p, but solid frame rates at 4K resolutions are possible without much sacrifice in quality. VR is equally good, and the GPU was more than a match for more intense titles, while maintaining excellent visual quality. The included free MSI Gaming App has a 'single click' setting to optimise your PC for VR use, as well as tweak or overlock the system. At the time of writing, we could only find the MSI RX 480 at one vendor, which is where our price above comes from, so make sure you shop around for the best deal.

Verdict

An excellent choice for mid-range VR performance on a budget.



Gigabyte Radeon RX 480

A stock design that'll save you a little dosh.

While Gigabyte has an RX 480 with a custom heatsink, it's not yet for sale in Australia. That said, the stock AMD reference design is just fine, albeit without some of the bling. The Gigabyte version runs at the stock 1,266 MHz boost clock, and has 8GB of GDDR5 RAM. We benchmarked it without an overclock, but the card happily handled the same frequency boosts as the competition. Under load, the card can be a little noisy, but also does a great job of venting heat outside the case. It happily ploughed through all our benchmarks, albeit a touch behind it's overclocked rivals, and handles DX12 particularly well. It does best at 1080p resolutions, but can manage 1440p and 4K resolutions at decent frame rates by dropping back the detail levels slightly. Likewise, VR performance is up there, managing high quality details without dropping under 90fps. There's three DisplayPort outputs, as well as a single HDMI and only needs one 6-pin power connection.

Verdict

A perfectly serviceable card, but we'd advise waiting for Gigabyte's upcoming G1 Gaming version instead.



RAM: 4GB GDDR5 **OC:** Max 1206MHz **Form Factor:** Dual slot **Power:** 1 x 8-pin **Ports:** 3 x DisplayPort, HDMI, DVI

RAM: 4GB GDDR5 **OC:** Max 1253MHz **Form Factor:** Dual slot **Power:** 1 x 8-pin **Ports:** HDMI, DisplayPort, DVI

RAM: 4GB GDDR5 **OC:** Max 1241MHz **Form Factor:** Dual slot **Power:** 1 x 8-pin **Ports:** HDMI, 3 x DisplayPort, DVI



\$379 | WWW.GIGABYTE.COM.AU

Gigabyte Radeon RX 470

Does the performance of the RX 470 stand up to VR?

The new Radeon RX 470 is a slightly cut down version of the RX 480, and sells for a cheaper price. It has fewer stream processors (2,048 vs 2,304), and 128 texture units, rather than the 480's 144. The memory is also a little slower, and the stock boost clock is 1,206MHz vs 1,266MHz – though this Gigabyte card runs at 1,230MHz. While prices for both cards vary a lot based on brand and extra features, the underlying difference is \$30-\$40, or about 10%. SteamVR still rates the 470 as handling VR with high details, and gaming benchmarks are not far behind the 480. It also often outpaces the GTX 970 (especially in DX12), and is cheaper. Still, it's hard to recommend this card over the RX 480, unless the RX 470 is already a stretch of the budget. Interestingly though, AMD has set the RRP at US\$179, or about \$260 in Australia with tax. If the RX 470 prices settle closer to \$300, then it could become a much more enticing buy for budget gamers.

Verdict

Handles VR-level performance, but needs to come down in price to be worth buying over more powerful cards.



\$419 | WWW.ASUS.COM.AU

ASUS Strix-GTX970-DC20C-4GD5

Can the aging GTX 970 still compete?

The older GTX 970 has to work hard to compete with newer GPUs, but still puts up an excellent showing. This ASUS Strix model features 4GB of RAM, and can boost up to 1,253 MHz in OC mode. The large dual fan heat-pipe cooler is pretty quiet under load, and can dial back to run completely silently for less-challenging games. It's a dual slot GPU, needs 8-pin power, and has HDMI, DisplayPort and DVI connections. The card also comes with ASUS's GPU Tweak app, which can be used for further overclocking, fan control, or online streaming. Compared to a barebones GeForce GTX 970, the ASUS Strix model offers a lot of extra features, but also costs as much as a basic RX 480. Performance can still best the 480 in a few circumstances, but it's generally left behind by an overclocked AMD card. Still, the ASUS 970 gave some great frame rates in normal gaming, and provided a pretty seamless and high quality VR experience.

Verdict

Solid VR and gaming performance, but a further price drop would be nice.



\$369 | WWW.GIGABYTE.COM.AU

Gigabyte GeForce GTX 970 OC Edition

One of the cheapest GTX 970s available.

Price alone is not the most useful metric for choosing a GPU, but this Gigabyte GTX 970 is undeniably quite affordable. It's 1,241MHz OC core frequency is slightly slower than the other 970s tested, but the difference in fps is minimal. It uses a single-fan blower style heatsink (drawing air from both sides), which keeps the card nice and cool, but makes a bit of extra noise under heavy load. Round the back it has an impressive three DisplayPort connections, as well as a single HDMI and DVI port. The card does need a 500W PSU, but only a single 8-pin power connector. It's happiest gaming at 1080p and 1440p, but it can give quite playable frame rates in 4K by dialling back the quality a little. It also handles VR just fine, but of course at slightly lower detail than the faster competition. While we'd still like to see even cheaper GTX 970s, the Gigabyte card actually manages a pretty good bang for buck.

Verdict

Good bang for buck means this last-generation GPU is still worth a look.



RAM: 4GB GDDR5, **OC:** Max 1279 MHz, **Form Factor:** Dual Slot, **Power:** 6-pin + 8-pin Power, **Ports:** 2x DVI, HDMI, DisplayPort

RAM: 6GB GDDR5, **OC:** Max 1873 MHz, **Form Factor:** Dual Slot, **Power:** 8-pin, **Ports:** 2 x DisplayPort, 2x HDMI, DVI

RAM: 6GB GDDR5, **OC:** Max 1809 MHz, **Form Factor:** Dual Slot, **Power:** 8-pin, **Ports:** 3x DisplayPort, HDMI, DVI



\$399 | AU.MSI.COM



\$519 | WWW.ASUS.COM.AU



\$489 | AU.MSI.COM

MSI GTX 970 Gaming 4G

Another older Nvidia card. Can it keep up?

Slightly more affordable than the newer competition, this MSI GTX 970 is also a little slower. How cheap it can be bought makes a big difference to its bang for buck, but we thought it'd also be worth comparing for those who already own a 970. What games and resolution you play at also make a difference, and the 970 generally fares better at lower resolutions. This MSI card buzzes along at up to 1,279MHz in OC mode, but can drop that right back to run silently. It features a large twin fan heat-pipe cooling system, with inbuilt RGB LEDs. The card supports DX12, G-Sync and is totally VR ready. Round the back end it has both HDMI and DisplayPort outputs, as well as dual DVI. It can run in SLI, which can help with better performance at high resolutions. The MSI GTX 970 is more than capable of giving an excellent result with VR, but still struggles to stand out from the newer competition. On the plus side, it has an excellent bundle of management software.

Verdict

Worth considering for the right price, especially if GTX 900-series cards are discounted in the near future.



ASUS ROG Strix-GTX1060-O6G-Gaming

Overclocked and ready for VR.

The ASUS engineers have pushed the ROG Strix GTX 1060 to new heights of performance, with an overclocked core frequency of 1,873MHz. Combined with 6GB of GDDR5 RAM, it makes for excellent gaming and VR performance. Of course the GPU does cost extra, but does include a range of features and software not available elsewhere. One handy option is the inclusion of four fan headers on the card itself. These can be used to directly control case fans, based on GPU temperature. Aside from keeping cooler under high loads, it's also a good way to optimise airflow for silent lower-end gaming. The card itself has a chunky three-fan heatsink, with customisable RGB LED lighting. Connectivity it good, with dual HDMI and DisplayPort, and a single DVI output. The card is quite efficient (drawing 120W), so only needs a single 8-pin power plug and 500W PSU. Bang for buck is reasonable, but especially in DX12 games, the GTX 1060 faces strong competition from the RX 480.

Verdict

Great performance, but the price premium means its best value for those who need some extra gamer focused features.



MSI GeForce GTX 1060 Gaming X 6G

Is it best to opt for the latest model?

Fresh from the MSI labs, the GeForce GTX 1060 Gaming X 6G is more expensive than the competition, but also offers a step up in performance. The exact difference is hard to quantify, as it varies from game to game. The card pulls furthest ahead with DX11 titles at 1080p and 1440p, but still offers excellent results with DX12 and 4K resolutions. Compared to the \$750+ GTX 1070, the 1060 provides significantly better bang for buck. It's VR results are also excellent, and will happily meet the specs for most games.

The MSI card boosts up to 1809MHz in OC mode, and uses a large custom heat-pipe cooler. It has built-in RGB LEDs, and can bring the fans to a complete halt under low load. The card only needs a single 8-pin power plug, and is efficient enough that it could actually save enough money over a year's gaming to offset the extra upfront cost. Round the back this one has HDMI and DVI, plus three DisplayPort connections.

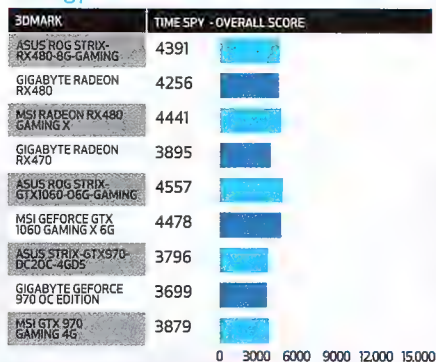
Verdict

Despite the slight price premium, this is one of the best affordable Nvidia GPUs available.



LABS BENCHMARK RESULTS

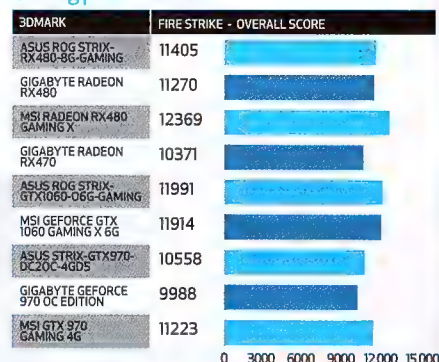
Gaming performance



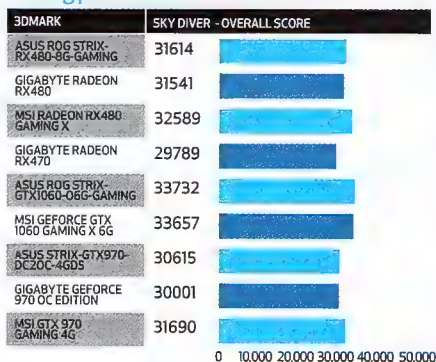
Gaming performance



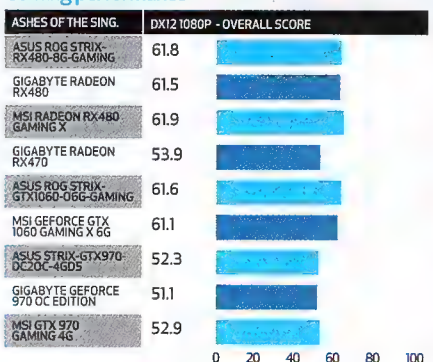
Gaming performance



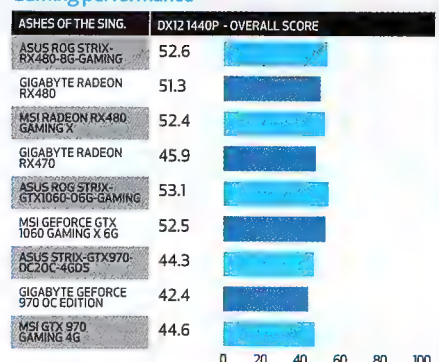
Gaming performance



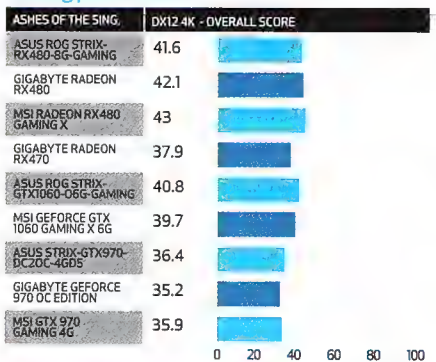
Gaming performance



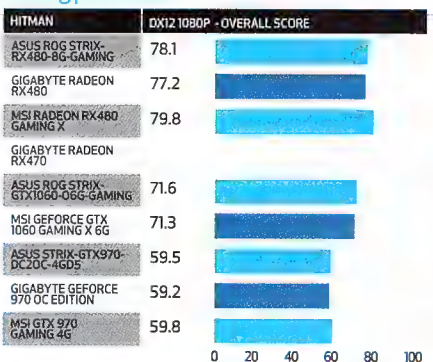
Gaming performance



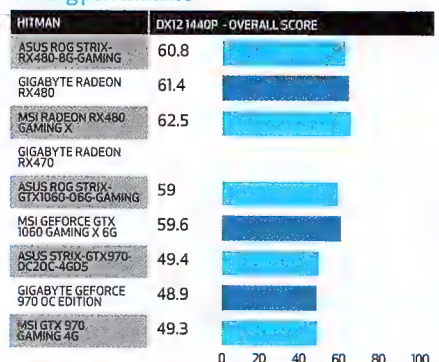
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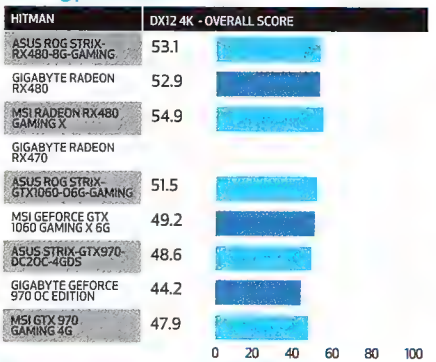
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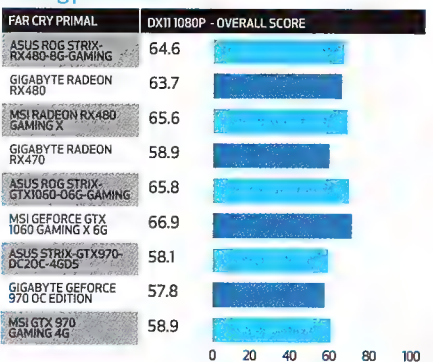
Gaming performance



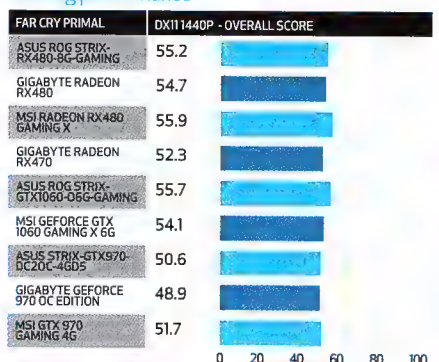
Gaming performance



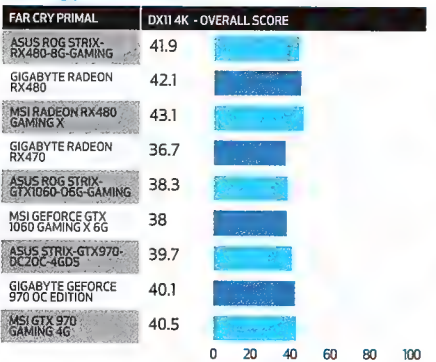
Gaming performance



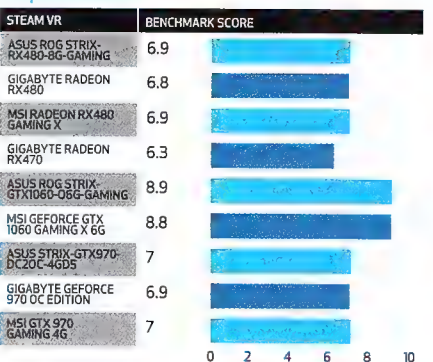
Gaming performance



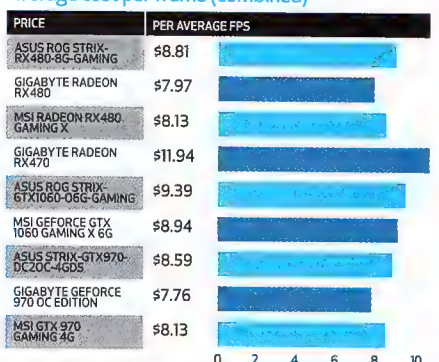
Gaming performance



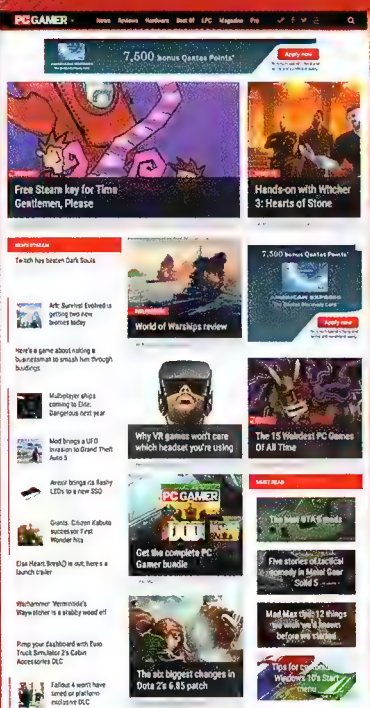
VR performance



Average cost per frame (combined)



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WWW.PCGAMER.COM



Build a budget VR-ready PC

Zak Storey puts AMD's RX 480 VR claims to the test in a \$1,300 rig.

Virtual reality: two words on the tip of the tongue of every tech journalist this side of the Pacific. And with good reason: As far as technological advances go, this is the biggest development in screen technology we've seen since CRT was retired in favour of LCD. But there's one caveat and it's a big one: the price. It's a heavy commitment – at least \$1,100 for a headset, and around \$2,000 (or more) for a rig capable of comfortably powering it. Is it any wonder why we, and the critics, are holding our breath on this one?

What does VR need? In short, more uptake and a lower price point. We now know that there are over 40 separate headsets currently making their way to market, including more affordable, yet still

high quality, products from the likes of DeePoon and other manufacturers.

This is a huge leap forward, as far as media development is concerned, because it will encourage game developers to create titles specifically for VR, thanks to the increasing user base. So that just leaves the system...

Let's say, hypothetically speaking, of course, that we're likely to see a headset in the region of \$600 – could we potentially game comfortably with VR for a little over \$1,700 in total? That's what we're hoping to prove with this little build. Centred around AMD's latest 14nm GPU (see page 48), and a budget FX system, we're taking a look at exactly how you would go about building a virtual reality system on a budget.

INGREDIENTS		
PART		PRICE
CPU	AMD FX-8320E	\$219
CPU COOLER	COOLER MASTER HYPER 212 EVO	\$40
MOTHERBOARD	MSI 970 GAMING ATX AM3+	\$149
RAM	CORSAIR VENGEANCE PRO 16GB (2X 8GB) DDR3 1866 MT/S	\$113
OS STORAGE	KINGSTON SSDNOW V300 SERIES 120GB 2.5-INCH SSD	\$69
AD STORAGE	1TB WESTERN DIGITAL CAVIAR BLUE 7,200RPM HDD	\$70
GPU	AMD RADEON RX 480 8GB	\$449
CASE	BITFENIX NEOS BLACK/RED MID-TOWER ATX	\$69
PSU	EVGA 600B 600W PSU (BRONZE)	\$99
TOTAL		\$1,277



AMD FX-8320E

For this build, we settled on an FX-8320E. Despite being an aging processor, this little beauty's eight cores should be more than enough to drive the latest games at 1080p and beyond. The chip comes in at \$219, running on a base clock of 3.2GHz (turboing up to 4GHz), and offering up support for DDR3 memory up to 2,400MHz on the AM3+ socket. Although not the tsunami of rendering power that you'd find on an Intel chip, the CPU performs admirably for everyday computational tasks.

The alternative solution from Intel would be the Core i5-4460 (it's a budget-friendly Haswell chip.) Its four cores provide very similar performance, but it isn't overclockable. It does provide PCIe 3.0, more SATA 6Gbps ports, and native USB 3.0 support, giving it the slight edge.



AMD Radeon RX 480

AMD's Radeon RX 480 is a 14nm FinFET card utilising a single six-pin connector. The RX 480 is a pretty stunning card when you can find it at the right price. At the time of writing, it had no equal when it came to the price to performance ratio. Not even Nvidia's latest GeForce GTX 1060 really troubles it.

But the real money earner is what AMD is including in the GCN 4.0 architecture. It primarily comes down to a nifty piece of logic embedded into version 4.0, known as Asynchronous Compute with Quick Response Queue, which enables the developer to tell the GPU when to complete a compute task ahead of a graphical one, as opposed to the GPU deciding off the cuff. This is crucial for VR, because it will ultimately reduce latency lag, and that notorious nausea.



Corsair Vengeance Pro 16GB

Memory selection is always slightly controversial. Frequency tends to increase alongside latency, so increasing overlocks actually provides very little in terms of an overall performance increase.

That said, the biggest winner is capacity, and although the FX-8320E at the heart of this little build is hardly the renderer of tomorrow, we opted to go for 16GB of Corsair Vengeance Pro DDR3 memory at 1,866MT/s. That way, there's absolutely no chance of the RAM being the bottleneck, and in theory, we do have the opportunity to upgrade to a Skylake B150 platform later on, without losing much in the way of performance, outside of power savings.



Cooler Master Hyper 212 EVO

Let's be realistic here. The FX-8320E is not a super-fast core, certainly not at stock. So if we can overclock it, we will. And, quite frankly, even at stock, the retail cooler that AMD ships with the eight-core processor doesn't cope very well with heat. At all. So with what little budget we had left, we decided to invest in a CPU heatsink worthy of our effort.

Ladies and gents, we give you the Cooler Master Hyper 212 EVO. It's not the best-looking heatsink out there, and it's not the most intuitive to put together. But is it solid and dependable? Yes. Will it keep your beans on ice? Well, probably not. But if you're looking for room temperature, it'll do just fine.



MSI 970 Gaming

The motherboard: the backbone of your rig. After opting for the FX-8320E, we had to find a suitable solution to house all that power. Unfortunately, finding new mobos in AMD's lineup is quite a challenge. It's certainly harder than with Intel, where each new chip denotes a new chipset.

The MSI 970 Gaming is a fantastic entry-level gaming motherboard. Featuring support for CrossFire and SLI, as well as DDR3 up to 2,133MHz, and a plethora of SATA connectors (at least, for an AMD board), there's no better choice. And guess what! It's black and red.



BitFenix Neos Black/Red

With a \$1,300 budget, it's inevitable that your spec is going to take a hit somewhere. More often than not, this is in the chassis department. For us, the choice was obvious. BitFenix does some fantastic, good-looking, and value-oriented case options. And the BitFenix Neos comes in at just \$69, putting us well within our target budget.

This cheap and cheerful chassis is a small, lightweight and stylish ATX mid-tower. Ideal for our build, it also includes some very intuitive features that you'd not expect to find on a case with such a low price point, such as 2.5-inch and 3.5-inch removable drive bays, the latter of which are tool-less. Additionally, if you fancy chipping in a little extra, you can drop another \$20 on the windowed edition, which nets you a red LED BitFenix Spectre fan as well.



Kingston SSDNow V3 120GB

You shouldn't even bother calling yourself a PC enthusiast today if you're not using an SSD for your operating system. The price of flash storage has plummeted over the last couple of years, to the point where you can buy yourself a 120GB Kingston SSDNow V3 for \$70. Granted, it'll run a little slower than some of the more premium options out there, but it's a damn sight faster than any HDD, that's for sure.

For additional storage, we threw in a 1TB Western Digital Caviar Blue 7,200rpm HDD (\$70). This will provide you with plenty of space for all of your games and any additional files you might need to store on your budget build.



EVGA 600W Bronze

The power supply will always be one of the trickiest components to choose. The biggest challenge is finding out how much wattage your lovely new PC is going to utilise, and then allowing for that. Your best bet is to use a calculator. You'll find a fantastic integrated PSU calculator at the top of your selected parts' list at au.pcpartpicker.com.

Ideally, the PSU is one of the components into which you should invest as much as you can. In short, if you buy too cheap a power supply, and it pops, it could easily take one or all of your components with it. Because of this, and our tight budget, we opted for an EVGA 600+ Bronze. Unfortunately, it's non-modular, but it does give us 600W of power and a bronze efficiency rating, which should be more than enough for our AMD build.

Time to get building

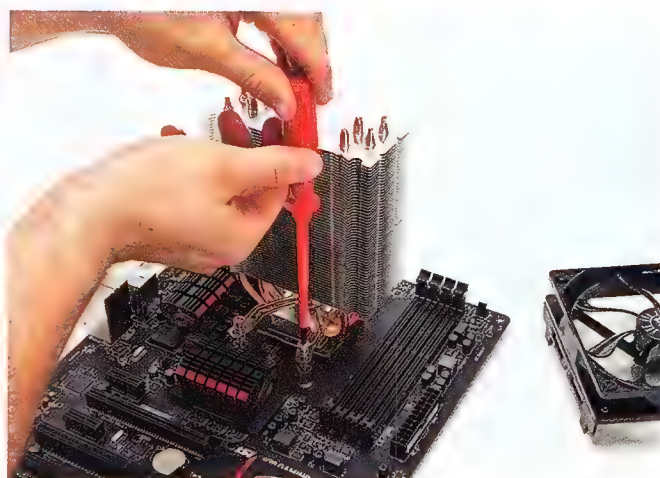
A step-by-step guide to putting your VR-ready PC together.



1 PREP FOR YOUR BUILD

It'll probably come as no surprise, but the best way to build a rig is to plan it well. The first and most crucial aspect of creating your new PC is setting up your build area. Make sure that wherever you decide to construct your machine, the area is free from distraction. Ensure you have all the tools you'll need to put your wee beastie together (usually a Phillips screwdriver, some scissors, and a set of needle-nose pliers for the fiddly bits). And last but not least, try to find a static-free area — avoiding woolly socks and carpets is usually best.

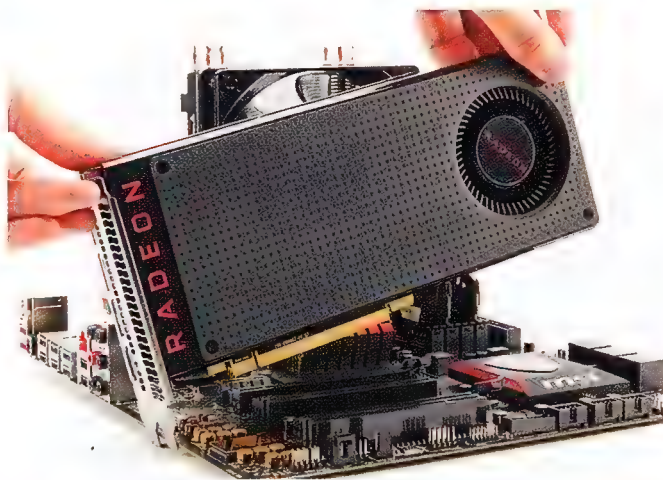
If you're paranoid, you can buy an anti-static strap, but if you can't find one, or are feeling stingy, ensure you regularly touch the casing around a power supply that's plugged into the wall, but powered off. This discharges all the static electricity that you're potentially building up in your body, and may possibly save yourself some heartache later.



2 INSTALL THE CPU AND HEATSINK

Start by building your PC outside of the case. If any components are dead, it makes it much easier to diagnose and disassemble. The mobo box also acts as a great anti-static test bench. Start with the CPU. Lift the retention arm on the CPU socket on the mobo, and align the FX-8320E with the socket (the golden triangle on one corner of the CPU should match up with the same triangle on the socket). Drop it into place, lower the arm back down, and lock it in.

Now, the heatsink. Secure the backplate with the nuts and bolts. Add a dollop of thermal paste to the middle of the CPU, then carefully position and screw down the heatsink, ensuring the intake of the fan faces the base of the case. Screw the heatsink down in a cross pattern, so you don't put excess pressure on one side of the CPU, potentially bending the pins. Then loop your CPU fan cable around, and plug it into the CPU fan header located above.



3 ADD THE RAM AND GPU

Next is the memory. Lift the tabs on either side of the DIMM slots, then line up the RAM, matching the gap in the stick to the notch in the mobo. Push it securely into place. Once you hear a satisfying click, you'll know it's correctly seated. It doesn't really matter which channels you use, but for maximum performance, it's often best to place them one apart (usually colour coordinated). Also, for this build, you'll want to place them as far away from the heatsink as possible, due to the size of the cooler, while still keeping them in the colour coordinated channels.

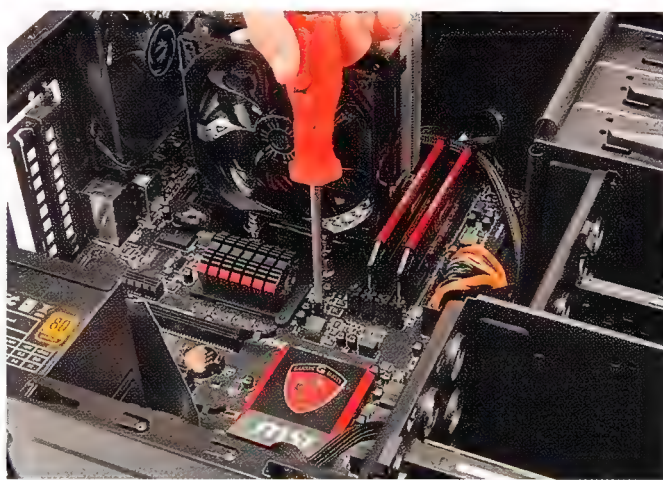
After this comes the graphics card. Gently take your GPU out of its anti-static bag (don't place it on the outside of the bag, as it's conductive). Remove the protective covers on the PCIe connector on the bottom of the card, and gently slot it into the top-most PCIe slot. Usually, we'd advise you not to touch the PCB on the back of the card, but depending on which graphics card you actually use, this may be hidden by a backplate anyway.



5 PSU AND CABLE MANAGEMENT

Now for the power supply. Remove the case's side panels, and slide your PSU into the allocated rear slot. Make sure the fan's facing down, so it can pull air from the underside of the case and exhaust it out the back. Push all of the cables through the space in the bottom of the case.

You'll want to plan which cables go where. Pull the CPU's eight-phase power up through the uppermost hole. Run it along the top of the mobo, around the RAM, and into the CPU power. The 24-pin power for your mobo can go in the cable-routing hole below the one you've just used for the CPU. Don't force anything, as you'll risk damaging the connector and power supply cable. Then route your front I/O cables around the back, and down into the bottom half of the chassis. Refer to the manual to connect your power/reset buttons and LEDs. Next, leave three SATA connectors in the rear, and the PCIe power cables in the front. Bundle the remaining cables together with ties, and leave them in the bottom.



4 ATTACH THE MOBO

Once you're confident that your new gaming hardware is working, it's time to throw this bad boy into your chassis. First, pull the GPU out of your mobo (simply move the clip located on the PCIe slot upward). Next, unpack your case and remove all the unnecessary components. This means two of the SSD trays can come out, plus two HDD trays, and the little welcome pack of screws. After this, take the rear I/O shield out of your mobo box, and place it into the rear of your case (make sure it's oriented the right way round), and push it into the slot at the back of the chassis, until it clicks into place along the edges.

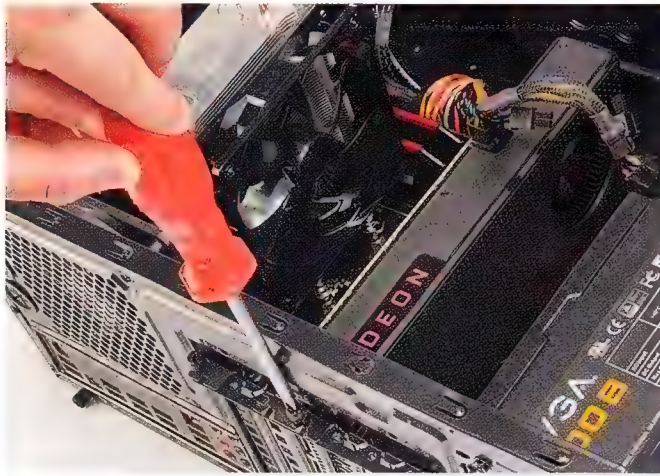
Next, align your mobo with the pre-installed standoffs, and screw it down. Remove the two corresponding PCIe slot covers on the back of the case, and reinstall your GPU, before securing it with an extra two screws. You'll have to remove BitFenix's ingenious PCIe slot cover — just pull it out, then click it back into place once you're done.



6 INSTALL THE SSD AND HDD

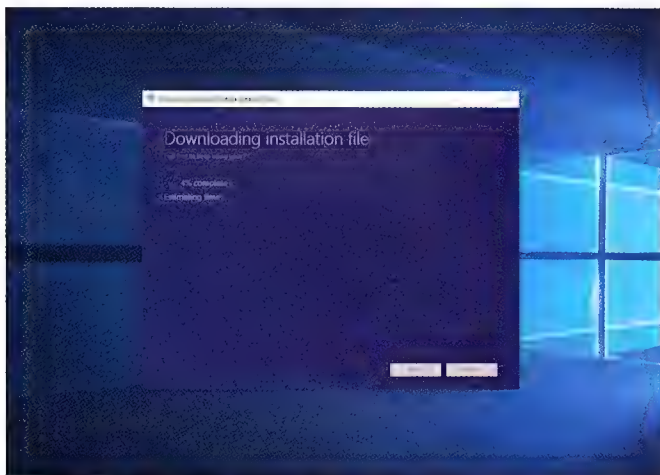
It's now time to install your hard drives. The BitFenix Neos comes with both 3.5-inch and 2.5-inch drive bays. To install SSDs, pull one of the 2.5-inch drive trays out. Place your SSD inside it (with the connectors facing away from the two finger grips), then secure the drive in place with four screws. Once it's snug, slide the drive back into the cage until it clicks. For the 3.5-inch hard drives, BitFenix has developed an innovative way to secure them. Simply take one of the drive caddies, pull it gently apart, slot the drive in place, and push the caddy back together. Again, with the connectors facing away from the two finger grips.

Now run two SATA cables from the first two ports on the mobo to your drives. Avoid the cable holes, and run them past that panel, around the back of the chassis. Due to the position of the cutout, you won't be able to run the cable through the hole. Then connect the two hard drives using the SATA power connectors we left behind the case earlier.



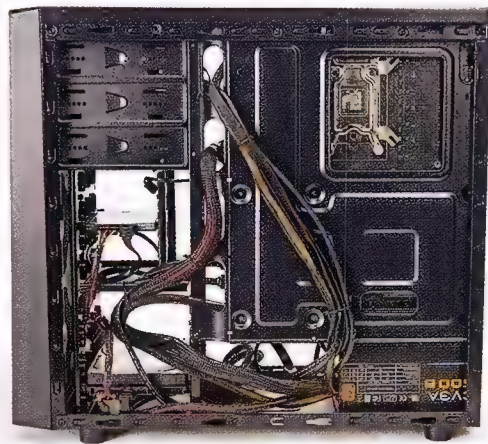
7 RESEAT THE GPU Next up, you'll want to reseat the GPU again. Simply line it up once more with the PCIe slot, and press it firmly into place, without using too much force. Try not to bend the connector, or you'll end up snapping it off, and ruining not only your GPU, but your motherboard, too.

Then run the six-pin PCIe power connector to the card, and install it as you did previously. Additionally, you could use a cable tie here to make sure the PCIe power is nice and cosy. It isn't entirely necessary to cable-tie everything down, but it's always advisable to do it where you can, because it improves airflow and generally looks better. It's also a hell of a lot easier to see what you're doing if you need to make modifications in the future, or if you need to clean out your PC.



9 INSTALL WINDOWS 10 We've found that the best way to install Windows 10 is via a fresh install using a USB stick. Get the ISO via your Microsoft account, then insert a USB stick (8GB is the usual minimum), and use Microsoft's Media Creation Tool to create a bootable disk. The USB stick will be formatted, so make sure any data on there is backed up.

Once you've created your bootable media disk, plug it into a USB 2.0 port at the back of your PC. (If you're running Intel, you should plug it into USB 3.0.) Then boot your PC and make your way to the BIOS. Find the USB stick in the boot order lineup (top of your screen), and drag it to the far-left. Hit F10, save settings and apply, and let your PC boot into Windows. Once in, you're going to want to jump on to another PC, laptop or phone, head to bit.ly/1TljD0d, and download the Windows 10 LAN drivers on to a USB stick. Install them on your rig, update the rest of your drivers, and voila — most of your work is done.



8 FRONT I/O CONNECTORS Now for the front I/O connectors. The cables should be positioned through the bottom of the chassis. Run the HD audio as far down as you can, along the bottom of the mobo, and into the HD audio connector on the bottom-left.

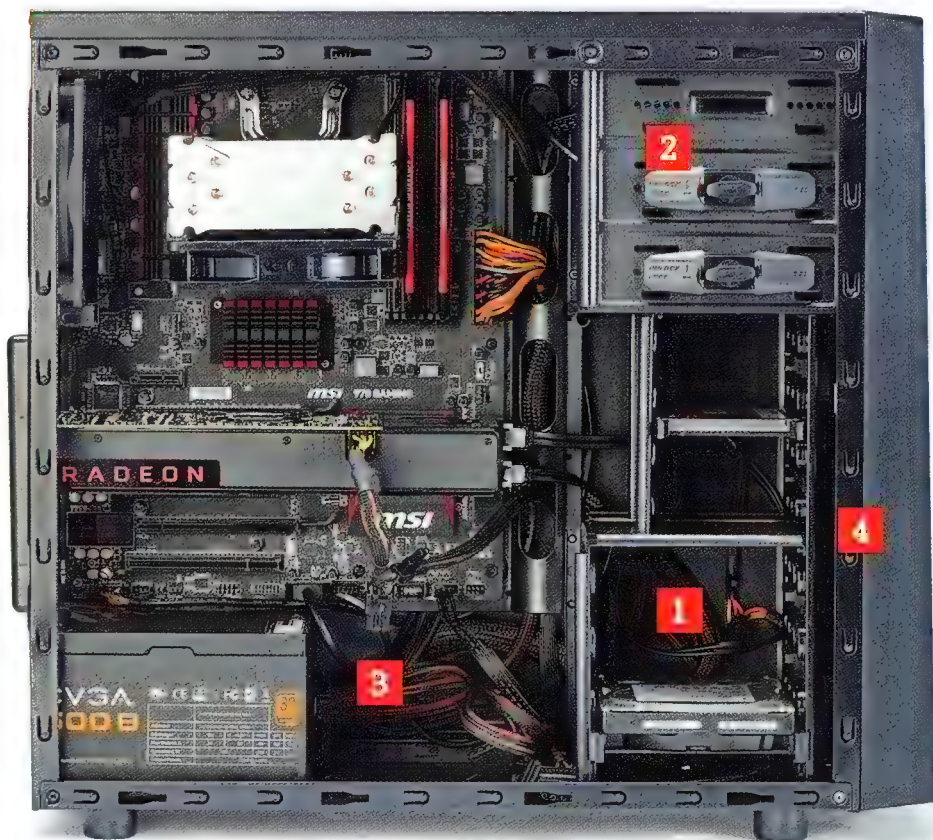
Next, grab the USB 3.0 cable, and do a similar run. The USB 3.0 connector is on the bottom-middle of the mobo. The USB 2.0 cable can be plugged into the right of the USB 3.0 cable.

The front power and reset switches aren't labeled on the mobo, so refer to the manual for the correct positioning of each pin. Then secure the side panels back on the chassis.



10 ADD PROGRAMS A quick and easy way to install a lot of commonly used programs is a website called Ninite. It's incredibly straightforward, and something we use almost every day. Head to www.ninite.com, select which programs you want to install, and select 'Get Installer'.

Ninite then downloads its installer, and automatically installs those programs, ensuring you get the most up-to-date software available. Adware-free, no hidden secrets. (It makes money from a B2B product, so don't worry!) Then it's just a case of installing your more bespoke favourite programs, and you're good to go!



- 1 The tool-less 3.5-inch bays make it incredibly easy to install any additional hard drives you might have, allowing for a total of three.
- 2 BitFenix even includes 5.25-inch tool-less bays. If you really do need an optical drive, you could throw one in here with relative ease.
- 3 A modular power supply would have been nice here, but the EVGA 600B is brilliant value, and comes with a great warranty.
- 4 The Neos also has support for two 120mm fans in the front of the chassis, which is ideal for a hot system, like this one.

Game on

So we come to the big question – the one on everyone’s lips: Does this machine meet the VR-ready specification? Has the impossible been achieved? Has Polaris and the 14nm manufacturing process finally made budget VR possible? Can we keep asking rhetorical questions that you can’t answer as a way of building the suspense?

The answer is yes, to all of them. Not by a foot, but by a mile. In Steam’s VR Performance Test, our AMD budget build scored an absolutely astonishing 6.6, bringing it nicely into the green bar, well beyond the ‘capable’ segment, and into VR-ready. And all for less than \$1,300, too. Apart from that, in-game performance was, relatively speaking, for the price, quite incredible. Both *Far Cry Primal* and *The Division* scored well into the fifties for average frame rate, and *Rise of the Tomb Raider* scored a respectable 35fps with everything ramped up – a title that’s notorious for hammering down our frame rates in testing. What is interesting, though, is that despite AMD’s continued development with DirectX 12, *ROTTR* actually averaged 4fps lower than DX11, indicating that Piledriver’s low overall single-core performance may have something to do with it.

Computational performance, on the other hand, was a far sadder story. In CineBench, we saw a respectable 507

points, but taking a quick look at single-threaded performance saw an astronomically low 90 points, almost 100 points lower than last issue’s Intel Core i5-6600K (issue 432, page 92). On top of that, SSD performance was a little lackluster. Although the Kingston SSDNow V3’s read speeds were well up at 511MB/s, the writes didn’t fair so well, scoring 105MB/s

The overall build process was fairly smooth. Obviously, at this price point, it’s never going to run completely smoothly – after all, we’re talking about a \$69 chassis and a non-modular PSU. Something to take note of is definitely a lack of length in the EPS power. It was quite a squeeze to thread it through the back of the chassis, then up and in – you could potentially get around this by using an extender, but then it’s a case of paying even more. Also, the Cooler Master Hyper 212 Evo CPU heatsink, once configured correctly, was an absolute pain. Not particularly difficult to install, just annoying.

Ultimately, this system is ideal for those looking to build themselves a nice little niche gaming PC, solely to be used at 1080p, and for general office work. It’s not a rendering powerhouse, or some monster of solid-state performance, but a perfect gaming rig that’s VR-ready. ■

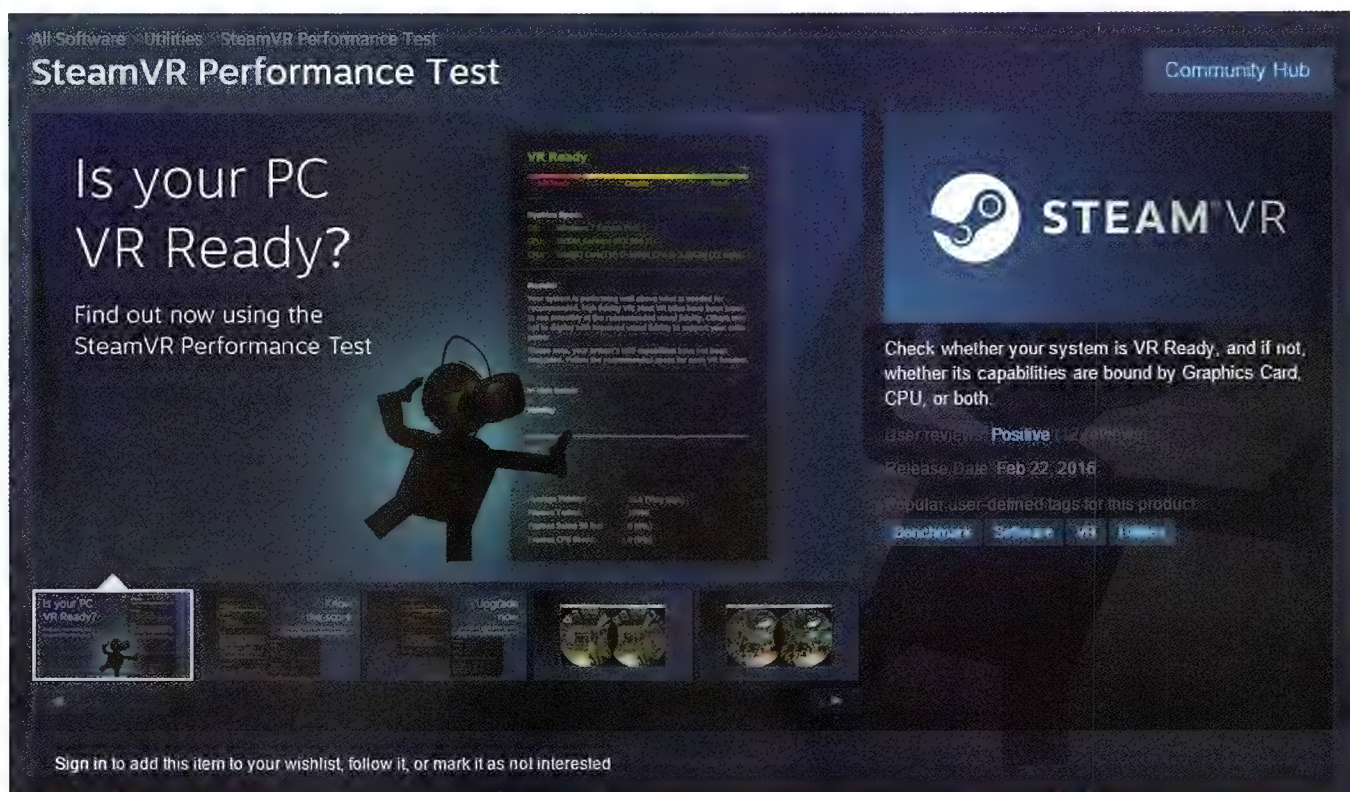
BENCHMARK RESULTS

	THIS SYSTEM
CINEBENCH R15 SINGLE	90
CINEBENCH R15 MULTI	507
TECHARP X264	11.98FPS
CRYSTALDISK SEQUENTIAL READ	511MB/S
CRYSTALDISK SEQUENTIAL WRITE	105MB/S
CRYSTALDISK RANDOM 4K READ	21.94MB/S
CRYSTALDISK RANDOM 4K WRITE	83.66MB/S
PCMARK 8 CREATIVE (ACCELERATED)	5,380
3DMARK FIRE STRIKE	7,835
RISE OF THE TOMB RAIDER	35FPS
FAR CRY PRIMAL	53FPS
THE DIVISION	57FPS

All games are tested on the ultra preset, with HD texture packages, and antialiasing set to the maximum possible. All frame rates are averages.

BUDGET VR BENCHMARKS	AMD BUDGET BUILD	APC TEST MACHINE
STEAM VR PERFORMANCE TEST	6.6	9.6
PRICE	\$1,277	\$2,985

APC test machine based on cheapest possible configuration. Best scores in bold.



Play Oculus games on the Vive

Grab your Vive and turn up the Steam for some gaming goodness.

Valve has been nice enough to open up its entire library of VR games to the Oculus Rift – you simply plug it in and everything works nicely in the Steam VR store. Obviously, games with room-wide tracking and motion controls won't work, but everything else is good to go.

Unfortunately, Rift hasn't been quite so generous; in fact, at launch, it had a headset check to make sure users couldn't play Steam VR games. Thankfully, that feature has since been disabled, but getting Oculus games to run on the HTC Vive isn't quite as easy. Not all of them will work, but many do. You're going to need a third-party piece of software called Revive to do so, and we're going to step you through how to do so.

STEP 1

Check to make sure the game you want to play is on the list of compatible games. You can find it here: github.com/LibreVR/Revive/wiki/Compatibility-list. This is constantly updated, so if it's not there one week, check again the following week.

STEP 2 - OCULUS HOME GAMES

Install the latest version of Oculus

Home, and update any drivers for the Rift and its added items. Skip the first-time setup. After checking your chosen game is compatible, download it to Steam. Now we need to grab Revive. The latest version can always be found here: github.com/LibreVR/Revive. Install Revive to your chosen location – you'll need to manually extract all of the files into a single folder – if you've already got it installed, fear not, you can simply reinstall it over the existing version. Now fire up SteamVR, and you'll see a new tab called Revive. Click this, and then select your new game of choice!

STEP 4 - STANDALONE UNREAL GAMES

Once again, you'll need to grab the latest version of Oculus Home and all drivers, and skip the first-time setup tutorial. Download Revive and extract all of the zipped files to a chosen directory. Now point your file browser to the directory where your chosen game is installed. Use Ctrl-F to find the phrase "Shipping.exe". Fire up SteamVR and drag the game's Shipping.exe file to the ReviveInjector_x64.exe in the Revive folder. Head back into the SteamVR interface, click on the Revive tab and start your newfound game.

STEP 5 - STEAM GAMES

Unfortunately, Oculus hasn't reciprocated Valve's generosity – it doesn't simply plug and play with Steam. In fact, many Steam games won't work at all with Revive, so make sure you check that compatibility list. For the last time, install the latest version of Oculus Home and all drivers. Download Revive and unzip all the files into a single folder.

Head to the properties tab of your Steam game, and uncheck 'Use Desktop Theatre while SteamVR is active'. Then go to the Local Files tab and click 'Browse Local Files'. Extract Revive into the folder that contains the game's executable. Start SteamVR and then your chosen game. You'll be told that the game doesn't support VR – ignore this and hit VR. Fingers crossed your game works.

Nearly all games will work with the Xbox One controller, except those with the need for motion controls. Fingers crossed Oculus allows SteamVR integration in the near future, as it will double the size of its already healthy store. ■

How to play old games in VR

We show how to bring new life to those old but much-loved 2D games.

We were pleasantly surprised at the rather large range of games available for launch for both the Rift and Vive. There are over 100 titles already up and ready to play, though the vast majority are relatively simplistic, built by tiny indie teams experimenting with new gameplay mechanics to see just what does and doesn't work in VR.

However, this leaves thousands of existing PC games that are just begging to be played in VR, yet they're not built to do so. Yet, due to the savvy nature of PC gamers, there are ways to convert these existing games into VR experiences. While we absolutely believe that the very best VR experiences are those built from the ground up for VR, it turns out that converting some of these existing non-VR games actually results in a pretty damn good VR game. We're going to show you how to do so using a tool called vorpX, a US\$40 app that converts a huge range of games into VR-playable titles. But first, let's take a look at the easiest method of playing normal games on the new VR kits

VIVE THEATRE MODE

The Vive has a nifty feature that allows you to play basically any non-VR game while using the headset. There's a catch, though – you're basically sitting inside a virtual cinema with a big screen in front of you, and the game is displayed on that screen. The Rift doesn't include this feature, but luckily Steam VR can be used with the Rift HMD. There's no head tracking or 3D to the image – just a big hovering screen in front of you showing the game you're playing. This also means you can't use the motion controllers of the Vive – you're going to be stuck using your good old keyboard and mouse or control pad. While it's a neat function, the resolution issues means games don't look anywhere near as good as when played on a normal 1080p screen. However, you can make the virtual screen massive, as in wall-sized, which some might find a decent trade-off for the resolution issues.

TRUE VR IN NON VR GAMES

There are now several apps on the market that allow you to take games that weren't designed for VR, and make them VR ready – this means adding head tracking and stereoscopic 3D. Currently, there's vorpX (cinema or full

injection), Virtual Desktop and BigScreen, but vorpX seems to be the favourite. Costing US\$40, it currently supports around 200 different non-VR games, and has just released support for the Vive.

Just because it supports so many games doesn't mean they're all great VR experiences. Because it doesn't support room-tracking, first-person games controlled via a control-pad can be a little nauseating at first, as your body's in-built accelerometers in your ear canals don't match up with the on-screen movement. It's possible to overcome this with practice, though, making games like *Fallout 4* fully playable. We prefer seated experiences, with racing simulators the most comfortable. Fast-paced games are also puke-inducing at first, but again, practice can get around this issue. Surprisingly, some of the most comfortable games are actually third-person titles.

Titles with highly detailed visuals and long draw distances aren't ideal due to the resolution issues present with both HMDs, though using super-sampling can go some way to reducing the jaggies. Just don't expect to be able to read intricate signs as easily as on a normal monitor – you're going to need to get a lot closer to objects to be able to read what's on them. Games with dozens of keyboard shortcuts are a pain unless you're a perfect touch typist, as you can't see the keyboard, so simpler control-pad style games tend to play better as well.

One great feature of vorpX is that it supports head and neck tracking in games that don't usually have this – for example, *ARMA III* has always had independent neck movement, but games like *Battlefield* don't. vorpX brings head tracking into nearly all of these games, so you don't need to use the control-pad to look around.

So what else does vorpX do other than introduce stereoscopic 3D and head tracking? Well, it's been built from the ground up to make use of multiple CPU cores, to ensure latency remains at a minimum. You're still going to need some hefty hardware, though – the basic GPUs required by the Vive and Rift just won't cut it when rendering the vastly more detailed worlds found in most 2D games. We're talking GTX 1080 or twin 970s to get the rock solid frame rate necessary in more detailed games.

Another feature is called 'EdgePeek and Image Zoom'. This allows you to look at screen elements that may not always show up on the Rift as they're outside the field of view. It also allows head movement during cut-scenes – without this, nausea can occur.

There's also a very basic on-screen VR keyboard that has up to 16 buttons. You simply look at a button to activate it, rather than have to lift your HMD up and go key hunting on your keyboard. Certain PC games only support mouse and keyboard for movement, but this can be tricky when using an HMD that blocks your view of the keyboard. To get around this issue, vorpX adds controller support to most games. Sadly, it doesn't yet allow the use of motion controllers, at least as far as we can tell – we were only able to test it on the Rift CV1, and there was no mention of motion controller support in the product feature page.

Most games these days do not support head tracking, with the exception of simulators like *DCS* and *ARMA III*. However, vorpX adds this to nearly all games, and goes one further. By using a basic anatomical model, it can also map neck movement based on head movement, allowing players to peak around corners.

As most games don't have the 110-degree field of view required by both the Rift and Vive, vorpX allows players to adjust the field of view dynamically until they find the most comfortable setting. It can also adjust the display area on the screens, shrinking them if the player prefers. Finally, there's a mode called 'Super-fast Depth Buffer and Geometry Stereo 3D Creation'. This allows the player to switch, on the fly, between a super-fast rendering method that guarantees 60fps in nearly every game, or a classic mode that renders twin stereoscopic views for a more immersive, but more hardware-intensive process.

Now that we've covered what vorpX does, let's see how to set it up and use it.

CONFIGURING VORPX

There's a basic Theatre mode just like Steam VR, and there's also a desktop viewer, but we're here to play some older favourites in VR mode. To do so takes a little bit of setting up, but it's not too difficult. We did all of our testing with the Rift CV1 using the Xbox One Wireless controller, paired to AMD's new RX 480 Radeon.



1 Fire up the Oculus software and make sure everything is working correctly from that side of the equation – ensure all firmware and software is up to date, and all of your devices are correctly connected and calibrated. You'll notice our sensor screenshot has an error – for some reason, despite being connected to a USB 3.0 port, it detected it as USB 2.0. Thankfully, it didn't cause any issues with using the device.

2 Now it's time to hit up the vorpX Configuration application. Start this and then go to the General settings tab. From here, you can choose which device to use, whether to enable head tracking/roll and audio, as well as access the expert settings. We'd suggest enabling the 'Run vorpX Control as administrator', for those games that need admin access to run. Hit 'Apply'.

3 The developers of vorpX have thoughtfully included pre-configured profiles for several hundred games already, tweaking the settings to what they feel is a good base line experience. For our test, we used *Metro: Last Light*. Now, this is a demanding game even in 2D, so knew we'd have to dial down some of the graphics options on our RX 480, so set everything to medium to low. Head to the Game Settings Optimiser tab and select your game, then click 'Optimise settings' and then 'Apply'.

4 To find out what the default virtual keys are, head to the 'In-game Key Bindings' section. From here, you can customise which keys are used for EdgePeek, camera centring and more. We stuck with the default settings just to keep things simple.

5 Making sure that the Oculus software is running, fire up Steam. Then start the game. You'll probably notice a few weird issues at first – things like the field of view

being slightly off, or not being able to move your head during some cut-scenes. We immediately lowered the graphics settings whilst increasing the super-sampling anti-aliasing to help with the jagged edges from the low resolution.

Once we began playing, we noticed the default FOV of 110 was just too wide, as we couldn't see things off the edge of the screen. We exited the game, went back to the *Metro: Last Light* profile and dropped the vorpX FOV to 85 degrees. Heading back into the game it was much easier to see what was on-screen.

6 To see a myriad of complex controls, hit 'E' whilst in the game. This opens up dozens of tweaks for vorpX, and allowed us to fix any remaining issues, such as slight crossover in 3D when viewing objects up close.

7 Enjoy your new VR experience! Despite the lower resolution, the increase in immersion was simply breathtaking. *Metro: Last Light* can be a scary game at the best of times, but when played in VR it's an entirely different, terrifying experience.

Despite how well vorpX eventually worked, we should point out that it took several hours to get the settings just right. This is not the kind of click-and-play experience that novices should expect. While there is a basic mode, it's unlikely that it will deliver the perfect settings. We highly recommend playing around with the advanced mode for a few hours to get things just right, as it will make the experience that much better.

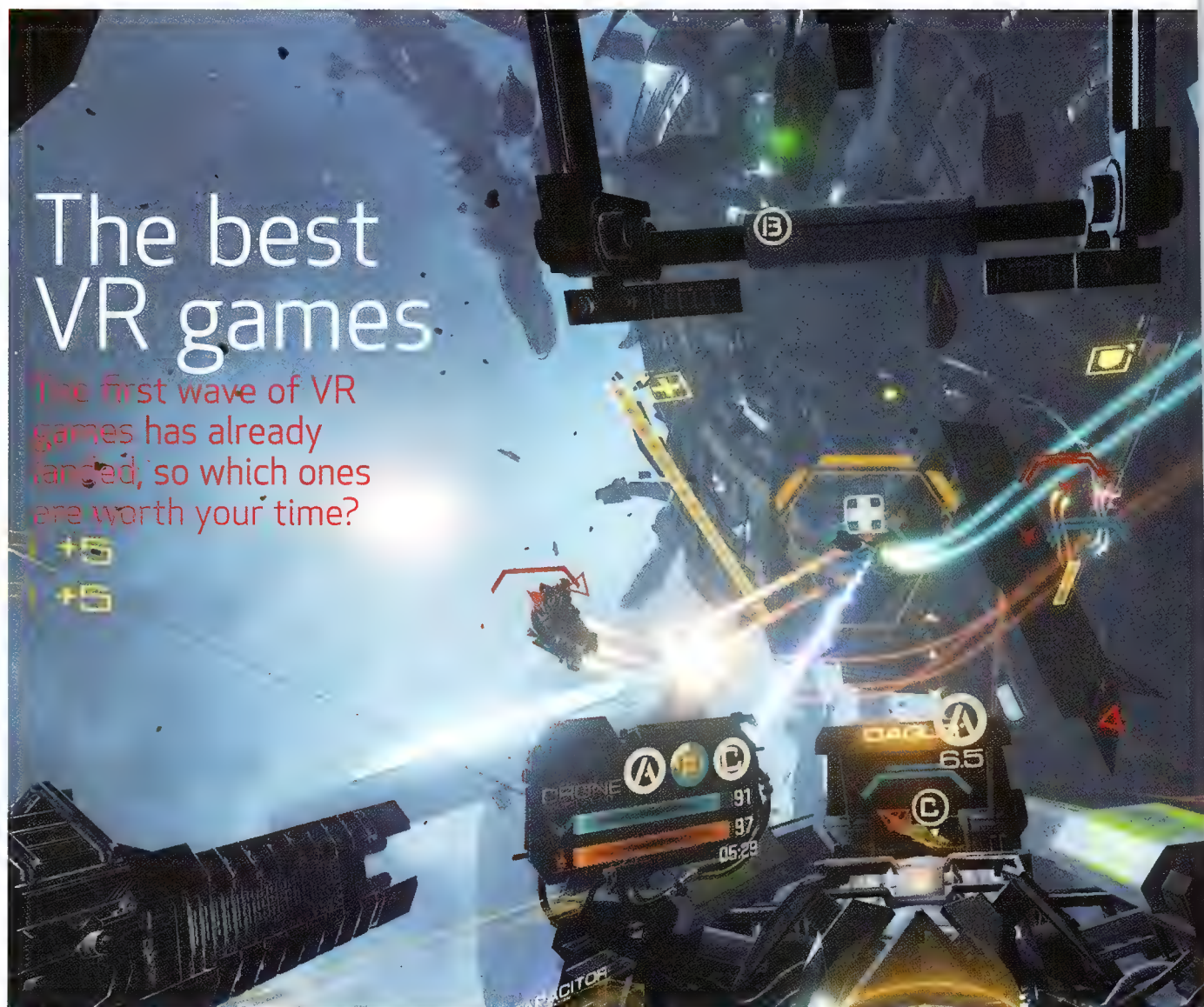
The good news is that vorpX is still very much a beta product – as time goes on, we're sure it's going to become much easier to use. It's definitely worth the US\$40 price tag for those who don't mind getting their hands dirty, but if you're looking for a quickfire solution

to getting older games to run in VR, we'd hold off on this one.

There's also still no denying that games built for VR definitely offer better experiences. They run better, look better and have a much lower tendency for nausea. Still, the ability to play several hundred more games in VR makes applications like vorpX a must-have for owners of VR kits, especially considering the minimal cost in the overall scheme of things.

You can grab the latest version of vorpX from www.vorpx.com, and the helpful community there will help you make the most of the 150+ games that are currently supported by this application. Now we're off to see how *Battlefield 4* plays in VR – and we can't wait!





The best VR games

The first wave of VR games has already landed, so which ones are worth your time?

It's obvious that the vast majority of the first generation of VR games are experiments to see what works. They've got crude visuals to maintain the crazy performance required, and most are only designed for a few short hours of play at most. Yet, we've seen the second generation of games on the way, and they've learnt so many lessons from the first generation. While today's games are fun yet simplistic, the VR games of 2017 are going to blow the first gen away... and will likely need some superior hardware to do so thanks to their much more detailed graphics.

Despite this, the first generation games are still incredibly impressive thanks to the establishment of the term 'presence'. This refers to the sensation that you're actually inside and surrounded by a virtual world, not peering at it through a 2D window. We've seen dozens of VR cynics immediately change their mind about VR after trying many of these games, going from unbelievers to figuring out

how to get their hands on a kit. What follows are some of the games we've used to do so.

EVE VALKYRIE

Ever wanted to hop in one of *Battlestar Galactica's* ships and fight it out in space? Welcome to the launch title for the Rift, developed by the folks behind *EVE Online*. It's a simple space deathmatch game; you jump in your spaceship, get bolted out docking port and then go head to head against a team of other human players. The thing is, you can look around your cockpit to see all around you, and lock up missiles in the process. It's an outstanding demo of VR, though it can be a bit intense for newcomers. It's also a little simplistic at the moment, with dogfights often devolving into turning fights that last for minutes.

Thankfully, the devs are adding new features all the time, with a new carrier attack mode recently included. This lets you do the famous trench run from *Star Wars*, having to fly down a narrow pathway to hit just the right

spot. This game has been designed from the ground up for VR, and it really shows — there's very little resolution issues or 'God Rays', and the seated experience helps to minimise motion sickness. Still, we'd recommend taking this game in small bites to start with, as it is rather intense at first.

THE CLIMB

How do you build a rock climbing simulator without having motion controls? It's an interesting problem that Crytek has managed to solve with this Rift-exclusive. Instead of using your arms to reach out for hand grips, you have to look at them. Then, using the Xbox controller, you squeeze either the left or right trigger to reach out to grab that hand-hold. The trick is doing it quickly; if you take too long between grips, you lose stamina and fall off the cliff. You can also chalk up your hands, but you have to do this quickly.

By far, the best part of this game is the visuals. It's one of the first VR experiences to deliver triple-A graphics on par with the best the PC has to offer,

EVE: Valkyrie comes from the same guys who developed EVE Online.

In Audio Shield, block oncoming coloured balls with shields in time to the music.

At the end of your climb, you can look back down and... Oh, shouldn't have! Bleh!

One of the activities The Lab has to offer...

which is probably why it requires slightly higher hardware specs than the minimums posted by both HTC and Oculus. There's also the sense of vertigo it delivers, which is something that 2D games just can't do. You really do feel like you're perched 700m up a cliff face with a gorgeous world around you, which makes it our second favourite VR game.

THE LAB

Designed more as an introduction to VR, Valve's *The Lab* is still a brilliant, albeit short-lived, experience to be had. It's actually a compilation of different experiences, and Valve keeps adding more to the mix. One demo has you using a bow and arrow to shoot weird troopers who are storming your castle, and the accuracy of the motion tracking here is impressive. There's also another demo where you simply play with a robotic dog on a field – it sounds boring, but it's hilarious. Another demo sees you flinging giant balls into huge piles of crates, trying to bring down as many as possible.

A shooter sees you dodging incoming balls as you shoot back, while another lets you stand on top of a virtual mountain, simply enjoying the view around you.

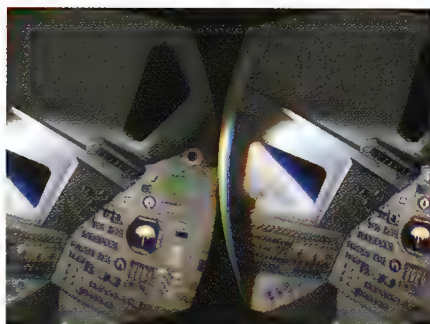
It'll only take an hour or two before you're bored with toying with a map of the solar system, but each demo shows off a unique aspect of VR, crafted with the quality that only Valve can bring to the table.

AUDIO SHIELD

One of our favourite VR games is also one of the simplest. Designed by a single developer, this Vive-exclusive makes extensive use of the motion controllers. In-game, each is turned into a shield – one is red, the other blue. You're then placed in a virtual

room with balls flying at you in time to different music, and you must block the right coloured ball with the correct shield. The algorithm that times the balls to the music is brilliant, so by the end, you feel almost as if you're dancing in time to the tunes, and you can even import your own.

Certain balls require you to touch shields, forming a new purple ultra shield, but before you know it, you'll be batting away coloured balls to the left, right, up and down. It really does give you a good workout, and plays in some way like a VR version of *Dance Dance Revolution*. At only US\$20, this is one of the best value games on the market, and we think it'll prove to be a hit at parties, where its mix of music and making people look ridiculous should be a hoot.



The Apollo 11 Experience

This short 30-minute interactive film is an educational tool used to show how the Apollo mission came together. Using a mixture of film and 3D-rendered environments, it's an amazing way to appreciate the mammoth tasks the Apollo team had ahead of them.



GunJack: Eve

It doesn't get much simpler than this. You're strapped into a turret, and wherever you look, you shoot. Waves of fighters approach in different patterns, and you're only allowed to take a few hits before it's game over. Blowing up certain fighters unlocks power ups such as the ability to wipe out all enemies at once. It's a very simple yet satisfying experience.

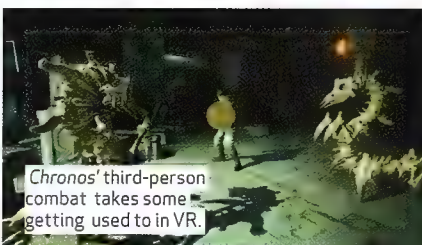


Elite: Dangerous

This is one of those games that some love, others hate. The sensation of flight is fantastic, but the detailed cockpit interfaces and distant targets can be hard to make out due to the resolution issues. It's also one game that is known to cause nausea, as rolling the aircraft is a huge part of the gameplay, and head-rolling in VR is a big no-no.



3D art has come to VR with Tilt Brush.



Chronos' third-person combat takes some getting used to in VR.



Hover Junkers is a fun multiplayer deathmatch game.

TILT BRUSH

More of an art experience than a game, Tilt Brush is nonetheless one of the most mentally stimulating VR experiences available. Built by those clever folks at Google, it's a 3D sculpting/painting program. Obviously, it needs motion controllers for this, so is currently exclusive to the Vive, but will come to the Rift eventually. One controller allows you to pick the material you'd like to paint with – it could be ribbon, bursts of tiny stars, glowing neon trails or dozens of other materials.

Then you simply hold down the control button to draw lines in space – but you can move around and through them, creating stunning 3D creations. In the hands of a novice, you'll come up with some impressive doodles, but give Tilt Brush to a real sculptor and the output is breathtaking. It's basically a new form of art we've never seen before, that lets you walk up to and through the piece. As you can see from the screenshot above, there are some stunning creations already and we can't wait to see how Google evolves this tool. It's already made it possible to export creations and look at them on Google cardboard, so whatever is next in the pipeline will probably be even more exciting.

CHRONOS

You'd think VR would be all about first person experiences, but to our surprise, some of the best have been in third person. Chronos is one such game – and the camera doesn't even follow

the main character. Instead, it works like the old *Resident Evil* games; as you enter a new area, the view switches to a new camera, which you can then manipulate with your HMD.

The gameplay itself is like a very basic version of *Dark Souls* or *Zelda*; think third-person, RPG, hack and slash. If it wasn't for the VR inclusion, we'd go so far as to say that it's pretty damn average, but the novelty of being inside the world more than makes up for the relatively shallow combat and basic graphics. Running to about 20 hours in length, there's enough here to keep you going, as the interesting viewpoint means you'll need to think about navigation, combat and defence in different ways to existing 2D titles. One for fans of third-person action games.

STAR TREK BRIDGE CREW

Okay, so this might not be out yet, but by god does it look incredible. Demoed at this year's E3, it allows several VR users to man the command deck of a *Star Trek* capital ship. One person might be the engineer, another the captain, another on weapons. Visually, it's totally captured the look and feel of the computer interfaces used in the show, and you'll be tasked with exploring an area of the galaxy known as the Trench. Your task is to find a new home planet for the Vulkan species, and along the way, you'll face new enemies, examine strange anomalies and chart out the entire sector. It's basically every *Star Trek* fan's wet dream come true.

HOVER JUNKERS

This Vive exclusive is an odd one. It's a multiplayer deathmatch game, and each player floats around the level on what is basically a hobbled together flying platform. It's possible to place armour plates in key positions, and then your goal is to fly around the level and find other flying platforms. Once you do, you're able to use the Vive's room tracking to hide behind parts of your ship, while using the motion tracking to fire a variety of weapons at your enemy.

It's rather rough around the edges, and controlling your platform takes some practice, but once you get the hang of it, it's one of the more fun deathmatch games available in VR. We just wish the network code would get a bit of a spit and polish as we've experienced quite a lot of lag when playing.

MINECRAFT

The game that changed the way children play has now made it into VR, and it's an obvious fit. Available on Oculus Rift and Gear VR, this Lego-like game now allows kids to walk around and explore their virtual environments. Sadly it's not on HTC Vive yet – the ability to manipulate blocks using motion controllers would be amazing, but Rift's Touch controller is only a couple of months away. We can only imagine how much faster and more intricate Minecraft VR creations will become when players can interact with the world using touch controllers – the amazing creations of the past will likely become basic building



blocks for far more fantastic, detailed worlds with this version.

JOB SIMULATOR

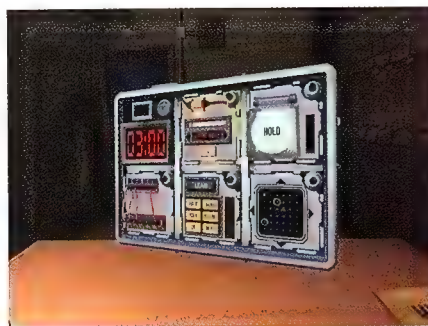
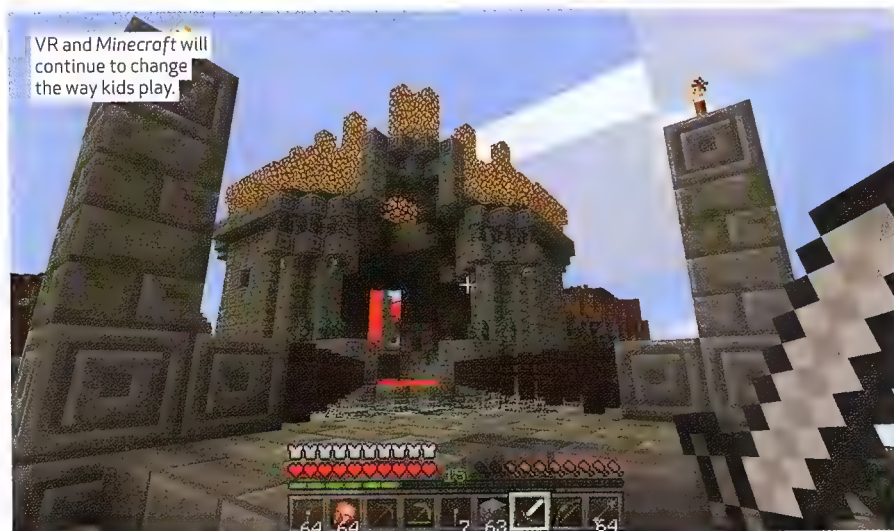
This bizarre title shows just how much of a difference VR makes to an average gaming experience. There are several different jobs you can take – office job, store manager, and so on – and it's your job to do the basics. And we're talking real basics here. Things like doing a photocopy, putting mustard on a hot dog, or chucking something in the bin. It couldn't sound more tedious, yet once you're in this hyper-exaggerated landscape something magical happens – boring activities become hilarious. There's plenty of humour packed in as well to keep it light and airy, but don't expect to play this for weeks at a time – like many of today's launch VR titles, they're basically experiments to see what works, and which get a little old after a few hours.

ASSETTO CORSA

Including this racing game was debatable, as some love the VR experience, while others find it severely lacking. This racing game has been on the market for several years already, and has built up a huge community who find its physics engine and graphics to be some of the best on the market. It also has rock-solid network support, making it the perfect game for racing leagues.

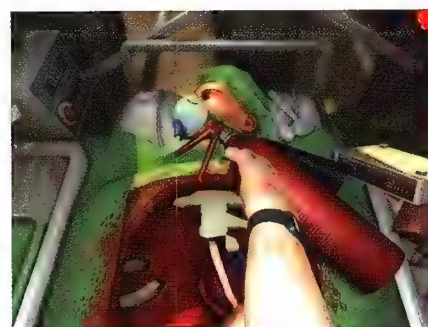
The developers of this game added VR support around six months ago, and it brings both pluses and minuses to the experience. There's nothing like sitting inside the car, being able to look around the cockpit and check your windows for other drivers. Combine it with a sit-down racing harness with steering wheel and the sensation is incredible.

However, graphics purists have real issues with the resolution. Due to many of the tracks having long straights and draw distances, it can be quite an issue to see what's coming up ahead..



Keep talking and nobody explodes

Designed to be played with a group of people, one person wears the headset and has full view of the bomb. They have to explain what they see to the external players, who then have to refer to a manual to figure out whether to cut the blue or red wire. A fantastic party game.



Surgeon Simulator

This five-minute experience from Valve tasks the player with replacing the heart of the gunner from TF2. It's hilariously gory, and takes advantage of the motion controls. Don't expect a perfect heart transplant simulator – when you're bashing a ribcage with a spanner, you'll realise they're not taking the subject matter very seriously.



Alien Isolation

While official VR support was promised at launch, it never eventuated. However, the code is there, and modders have unlocked it to work with certain headsets. One of the best VR experiences due to the close range of the environments and darker light scenes, this game is utterly terrifying. ■

Upcoming VR tech

With everything so new and shiny, it's an exciting time to be involved in VR.



It's also worth remembering that this is barely the beginning of a new form of technology that could be as revolutionary as smartphones or even the internet. We've only just got the basics in place as of several months ago, so what's to come in the future to make the VR experience even better?

BETTER HMDs

Today's HMDs use screens with a resolution of 2,160 x 1,200, which sounds fine until you use them. Some believe that, to match reality perfectly over a field of view of just 90 degrees, we'll need screens with a resolution of 54,000 x 108,000. Obviously, that is several decades away, but the good news is that we should already see a doubling of resolution by 2017, with Samsung recently demonstrating a 5.5-inch 4K screen designed for VR. 8K per eye is seen by many as being almost good enough to replicate reality, and that appears to be just two years around the corner. Of course, driving so many pixels is going to require some serious PC horsepower, but luckily, GPU hardware seems to be increasing at similar speeds.

Other improvements to HMDs will be lighter units, different screen technologies that better replicate depth, such as Near Eye Light Field screens, as demoed in the last year by Nvidia. A wider field of view is also desirable, and one of the simpler problems to solve. There is also currently research into HMDs that actually project the image directly onto the retina, and there's already a product on the market that does so — the Avegant Glyph. Another possibility is the use of contact lenses with built-in screens, with several patents lodged for these devices.

BETTER MOTION TRACKING

Currently, we're limited to interacting with our virtual worlds via Wiimote-like controllers that provide very basic interactions with the virtual environment. While these already feel incredible, plans are afoot to make these interactions much more accurate, right down to finger tracking. Many believe that gloves will be the simplest way to do so, but there's a company with existing technology that just might do the job. Leap Motion released a finger-tracking device that

"Hopefully we don't all end up living in liquid cocoons and operating as batteries for a highly evolved AI race."

uses laser tracking as a mouse replacement about a year ago, but since then, many have realised that, by strapping a higher resolution version to the front of a HMD, it's the perfect way to capture finger movement down to the millimetre.

One problem that will be much harder to figure out, though, is force reaction — for example, the resistance felt when a virtual sword clangs against a virtual shield. Without custom built devices for each experience, it's a challenge that seems insurmountable. One company that recently folded had designs for a full body suit that used electric stimulation of the muscles to try to recreate the feeling of resistance missing from VR. It was basically one giant version of those weight loss devices that cause muscles to flex involuntarily, and the science seems relatively sound.

There's also the issue of touching difference surfaces — how do we mimic the feeling of skin versus rock? This is another reason many believe gloves, and eventually full body suits, will offer the best solution for both motion tracking and touch. There are already materials in existence that can change

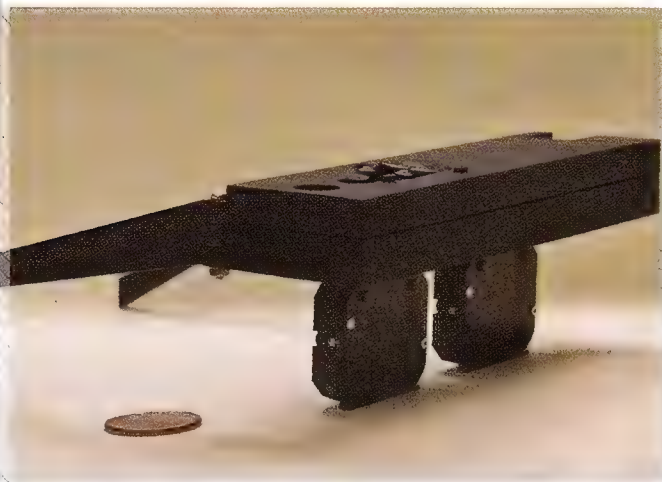
their texture via the use of nano-materials.

In the meantime, we're simply excited about the upcoming release of Oculus' Touch controllers, which will finally allow players to interact with their virtual worlds in much the same way as the Vive's motion controllers. We've had a chance to play with them, and find their ergonomic design feels much more natural than the Vive's wands — and there's also the chance that they'll bring room-wide tracking with them. Stay tuned for more info on release dates and prices soon.

OMNIDIRECTIONAL TREADMILLS

Valve has cleverly got partway around the issue of simulator sickness via its use of room-wide tracking technology. As the player is actually walking around the play area, the liquid in our inner ears corresponds to the movement in the game. However, there's the issue of this being limited to a smaller space. Enter the omnidirectional treadmill. This is simply a treadmill that allows the user to walk in any direction, and there's already one on the market. The Virtuix Omni is currently retailing for US\$699, and uses a very slippery dome paired





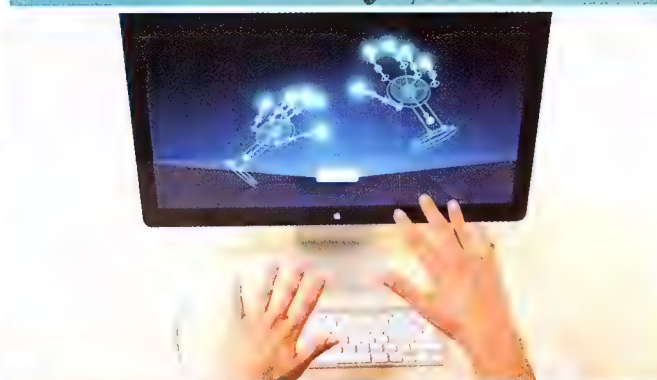
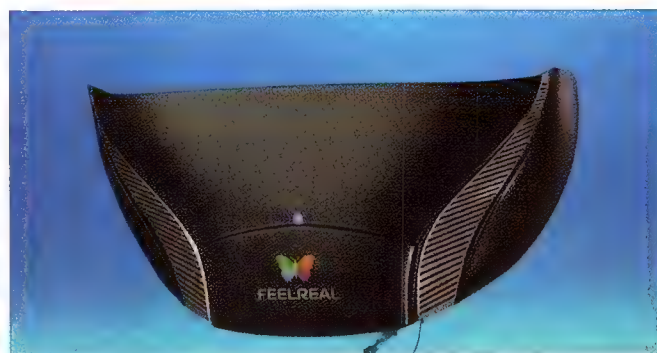
with special shoes to allow the player to run or walk on the spot, in any direction. A special harness keeps the player upright, and also allows the player to crouch or jump. Unfortunately, the version we saw was in Alpha condition — while the hardware looked usable, the software is nowhere near complete.

SCENT AND TEMPERATURE

This problem is relatively easy to solve, with devices on the market that can already mimic different smells depending on the cartridge used within. There's already a Kickstarter for a device called the Feelreal, which is basically a helmet that sits over the HMD. It promises to deliver various fake scents, as well as include tiny fans and temperature controls to mimic weather conditions.

DIRECT BRAIN CONNECTION

The ultimate in VR is the stuff of science fiction — plugging directly into the brain and taking control of the relevant input segments to inject a virtual version of the world over the real world. We're already seeing electrodes being implanted into human brains to control bionic limbs, and electronic eyes that tap into the optic nerve to serve up a very basic view of the world to those who are blind, so tapping directly into the brain's relevant areas isn't as far fetched as it seems. Hopefully, we don't end up living in liquid cocoons, living as batteries for a highly evolved AI race and having to rely on a guy called Morpheus to free us.



High Resolution for VR

SMARTPHONE VR
HARDWARE

apc
HOT PRODUCT



VR on the cheap

Don't have the dosh to spend on a full VR rig for your PC? No worries. Joel Burgess and Paul Taylor show you how you can get on board for next to nix using your smartphone and a cheap headset viewer.

There's been no shortage of coverage of the HTC Vive and the Oculus Rift in the pages of APC, but unless you have a penchant for being at the cusp of PC development and happen to have access to a sizable disposable income, then these devices may be a little out of reach. At the other end of the scale are far simpler but, at times, impressive VR headsets that utilise your existing smartphone for a fraction of the cost.

Samsung's Gear VR is the big one here, and it's gained fame thanks to its Oculus Rift partnership, but there are actually a wide range of smartphone VR headsets available. This roundup's collection of VR headsets come to life with good-quality, high-resolution screens – and with a pair of headphones and a Bluetooth controller, you can have a totally portable VR rig that'll keep you entertained for hours.

We've tested a variety of units and cherry picked our favourites to give you the ultimate cheat sheet for smartphone VR.

WHAT YOU NEED TO GET STARTED

A RECENT SMARTPHONE

If you've got a smartphone that's less than two years old, chances are it'll be VR-capable – although, obviously, the faster it is and the bigger and higher-res the display, the better.

A VR HEADSET VIEWER

A basic clone of Google's Cardboard viewer – which, as the name suggests, is mostly made of cardboard – can be had for less than \$20. For prolonged use, though, you'll want something more comfortable; prices for more robust headsets start at around \$40 and go up to over \$200.

VR-COMPATIBLE GAMES, APPS AND MOVIES

Despite VR being relatively new, there's a surprising abundance of content on offer, both on Android and iOS. Android even offers some dedicated storefronts – the Google Play Store had a dedicated Cardboard section (see tinyurl.com/APC433-GCard) and if you have a Gear VR, you'll be able to browse and download apps and games from the Oculus Store (www.oculus.com/experiences/gear-vr).

OPTIONAL: A SMARTPHONE-COMPATIBLE GAMEPAD

One of the big hurdles for smartphone VR is actually navigating menus or controlling games and, as such, having a made-for-mobile Bluetooth controller is a welcome addition. Many games actually require it to play.

\$49.95 | WWW.KAISERBAAS.COM

Kaiser Baas VR-X Headset

Top of the line for not much coin.

Kaiser Baas' rugged, well-appointed unit fits even the largest of phones (phablets not included), and uses a clever racking system to load and unload your device. It's an ingenious solution that makes mounting phones a breeze. Wired headphones can also be used as there's a handy vent on the side, wide enough to fit even the fattest of cables, without letting light bleed in. Similarly, a sliding panel that exposes your smartphone's camera for AR titles performs a similar trick, making the VR-X the best out of all the Cardboard compatible headsets we've seen.

While there isn't a button for tapping the screen (essential for some apps, unless you have a Bluetooth controller), it does feature a rocker button compatible with phones that have a magnetometer built in.

Lenses are adjusted independently from each other with dedicated sliders, and while you won't be able to wear glasses with this, it's a very comfy and snug fit. Plus, it certainly looks the biz.

Verdict

Comfy and well-designed, with handy cable vent and compatible with a large range of devices.





\$159 | WWW.SAMSUNG.COM/AU

Samsung Gear VR

You'll need to gear up for the best in smartphone VR.

The first step for superior smartphone VR is having a powerful handset with a quality screen and Samsung is no slouch in these departments. That said, the Gear VR's main strength is also its biggest weakness as the headset only works with a small pond of high-end Galaxy phones.

Samsung is only half the story, though, as the VR-bigwig Oculus is responsible for the software side of the Gear VR. The Oculus store is hardwired into the Gear VR experience, downloading alongside the Samsung VR update and being accessible exclusively through the Gear VR headset. But the list of apps and games available to Gear VR is superior to what you can get through Google Cardboard or on the Play or App stores.

Part of this comes from graphically-demanding, Samsung-exclusive titles like *Eve Gunjack*, *Anshar Wars 2*, *Darknet* or *Minecraft*, which are all good enough to be offered to the Oculus Rift as well.

Verdict

Compatible with only Samsung flagships from Galaxy S6 up, but with a great range of games.



\$49 | WWW.ANYWARE.COM.AU

VR Box

A nifty headset and controller combo.

Take a look at this headset and you'll see that it's nearly identical to the Kaiser Baas unit. The sliding bracket, panel for your smartphone camera, lens sliders — all of them have come from the same mould. It's just as comfortable, too. While the VR Box loses out on the button on the side of the headset, in its favour, it gains a small, Nintendo Wiimote-like Bluetooth controller. The controller has several functions, making it operate like a mouse, media remote, game controller and VR mode. Not all phones are compatible with this last one, according to the instructions, but mash your way through them all and you'll find something that works. The experience is less than stellar — the analogue nub is actually an eight-way direction pad with a stick bolted on top.

While you're better off investing in a proper control pad, for the asking price, you're getting a bargain, and it should be enough to get you through most VR titles.

Verdict

Comfy, and included controller is a plus but feels a bit cheap.



\$99 | STEELSERIES.COM

SteelSeries Stratus XL

Take your gaming into the stratosphere.

Since Samsung rescinded sales of its own wireless gaming pad in Australia, it's been plugging the Stratus XL at the bottom of the official Gear VR page, but if you thought that the Samsung Pad was pricey, then you'll balk at the cost of this one. For the most part, this controller feels like the quality you'd expect to pick up for your console complete with ergonomic Xbox-like wings and joysticks coated in a premium soft touch rubber with a predictable slipperiness to them.

And although the D-pad feels mushy for a controller of this price point, the nicely weighted buttons, triggers and bumpers make up for the oversight and combine to make a controller that feels nice and robust. The controller has a bulbous undercarriage that accommodates two double-A batteries that make it notably heavier and less self-sufficient, but there is an argument for having a 40-odd hour battery life. Other than that, we can't fault the Stratus XL.

Verdict

A rather expensive controll, but with a quality finish and great performance.



The best smartphone VR apps, games and movies

We've rounded-up some of our favourite experiences to help you get started.

So what can you actually do with VR on a smartphone? Well, VR videos have been around on YouTube for a couple of years, and they now have a natural home with headsets. Moving your head while watching a VR video means you get to see a 'proper' 360° view, rather than, say, flicking your finger across the screen to see what's above or behind you. This translates very well to games, too. We've found a good number that take the freedom that VR affords, and the experience, with the right headset and accessory, becomes incredibly immersive. We're taking the first steps with VR, though we already see some examples here as standouts in their genre. We can't wait to see what they inspire next.



Smash Hit VR

FREE (GEAR VR OCULUS STORE EXCLUSIVE)
WWW.SMASHHITGAME.COM

This on-rails gaze shooter pins your view to a consistently forward-moving point of reference through a strangely abstract world of seemingly infinite geometric dreamscapes. Your task is to throw metallic balls at moving panes of glass before they collide with your head while shooting at sporadically placed glass prism's that reward you with more ammunition (if you run out, the game is over). The controls are simple to pick up but difficult to perfect with aim managed by where you're looking and shooting requires a tap on Gear VR's touch pad. The camera never accelerates, so there's little chance of motion sickness.



Bombsquad VR

\$4.49 | ANDROID, IOS, OCULUS STORE
WWW.FROEMLING.NET/APPS/BOMBSQUAD

Never have we felt it necessary to run the full length of a game's arena as a wind-up for a punch, but *Bombsquad VR*'s physics-based damage system will award more damage to the fist that travels fastest into someone else's head, so a good run-up is well rewarded. But other than an impressive physics system, this third-person squad-based battle arena has a number of other features that make it a standout smartphone VR title. On top of being the only smartphone VR game where you can play against up to eight friends, it's a lot of fun and has the most comprehensive menu and settings system we've come across.

Herobound First Steps

FREE (GEAR VR OCULUS STORE EXCLUSIVE) | GUNFIREGAMES.COM/HEROBOUND-SPIRIT-CHAMPION

The Herobound series offers the first real first-person combat in VR free as a bonus for the \$14.99 Spirit Champion reward. The third-person damage feedback is pretty heavy-handed, but it's a simple introduction to the world of VR. The first steps are well explained, and the game is a good introduction to the world of VR.

Within

FREE | ANDROID, IOS | WITH.IN

Think of *Within* as a virtual escape room. It's a 3D escape room game that's been around for a while, but it's been reimagined for VR. The game is a 3D escape room game that's been around for a while, but it's been reimagined for VR. The game is a 3D escape room game that's been around for a while, but it's been reimagined for VR.

Netflix for Gear VR

FREE (GEAR VR OCULUS STORE EXCLUSIVE) | TINYURL.COM/APC433-NETFLIX

For content fans, there's a lot to be said for the Gear VR. It's a 3D escape room game that's been around for a while, but it's been reimagined for VR. The game is a 3D escape room game that's been around for a while, but it's been reimagined for VR.

Galaxy VR Cardboard Space FPS

FREE | ANDROID, IOS
WWW.SILICONDROID.COM

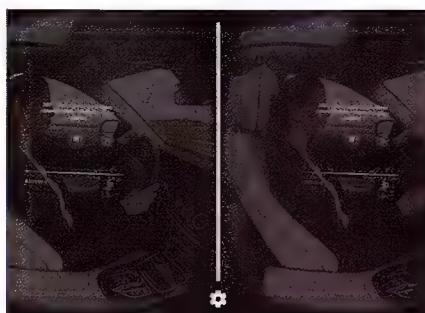
For content fans, there's a lot to be said for the Gear VR. It's a 3D escape room game that's been around for a while, but it's been reimagined for VR. The game is a 3D escape room game that's been around for a while, but it's been reimagined for VR.



Land's End

\$12.99 (GEAR VR OCULUS STORE EXCLUSIVE)
WWW.LANSENDGAME.COM

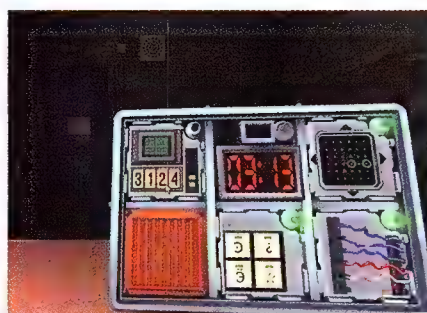
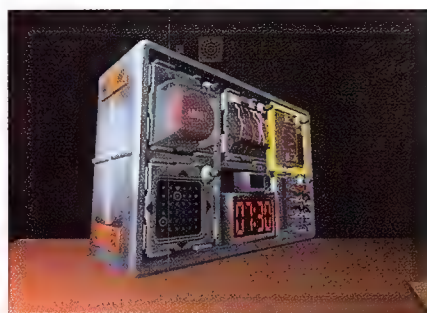
Another Gear VR exclusive, brought to you by the team behind the utterly engrossing and amazing *Monument Valley*. This puzzler sets you on a mysterious set of archipelagoes, the cartoonish world around you soaring above and outward. The idea is to literally connect a set of dots to progress onto the next puzzle, and all you need to do is move your head and link them together as you soar around the world. As you make your way through the five chapters, the puzzles get increasingly difficult, and new elements are gradually layered on top.



YouTube

FREE | IOS, ANDROID | YOUTUBE.COM

Well, of course, you have YouTube. The majority of the videos here aren't 3D, but rather 2D videos shot in a way that means you can swivel and pivot around to look in all points of direction, seeing what's above, behind and below you. It's a boon for anyone seeking adventure, or sport, and it's as simple as typing in 'VR' in YouTube's search function to find something. There ought to be no shortage of videos, either, with cameras from companies such as GoPro and 360fly being readily accepted by would-be filmmakers.



Keep Talking and Nobody Explodes

\$14.99 (GEAR VR OCULUS STORE EXCLUSIVE)
WWW.KEEPTALKINGGAME.COM

This absolute standout is a bomb-defusal game, where one person wears the Samsung Gear VR headset and the game places them in a room with a bomb, while a party of their friends in the real world has to decipher instructions to disarm the explosive and read it out to the player. Making things tricky is a countdown timer for the person wearing the headset, while the rest of the team has a sheaf of paper they have to plough through and pipe instructions to the person stuck with the bomb. Each bomb is procedurally generated, too. Tense, exhilarating and, yet, very funny.

Minecraft for Gear VR

\$10.99 (GEAR VR OCULUS STORE EXCLUSIVE) | MINECRAFT.NET/EN/VR

Take the Pocket Edition of the hit block-building game and turn it into a VR game. It's the simple version, but the VR version of it is a lot more fun than that. For one, it battles motion sickness by tweaking the way you're used to in the world, and also removes the action you can game and make from the immersive you're looking.

Eve: Gunjack

\$14.99 (GEAR VR OCULUS STORE EXCLUSIVE) | WWW.GUNJACK.COM

If you want a stunning visual first in the VR world, then there's no better example than the CCP Games' stylized space shooter *Eve: Gunjack*. This small shooter has you riding a ship with a gun that is aimed to a specific point in the independently generated world. By using your head to aim, shooting down enemies and collecting things, upgrade your ship and then you're on your way to the next level.

Jaunt VR

FREE | ANDROID, IOS, OCULUS STORE | WWW.JAUNTVR.COM

Another content free, *Jaunt VR* is a thousand of 1-minute videos that fully immerse you in a wide range of topics, including nature, science, history, sport, education and more. The interface is intuitive and sometimes with all the details, you can be looking at a single image or a full 360-degree view.

Star Wars

FREE | ANDROID, IOS WWW.STARWARS.COM/GAMES-APPS/STAR-WARS-APP

(Not strictly a VR app, but *Star Wars* is a series of games that are available on Oculus Rift, HTC Vive and PlayStation VR. You can't do much, but the experience is a very fun one. The game is a first-person shooter, and it's a very fun one. The game is a first-person shooter, and it's a very fun one. The game is a first-person shooter, and it's a very fun one.



THE PROBLEM WITH THE FUTURE OF VR ISN'T WORKING OUT WHAT IT LOOKS LIKE, IT'S WORKING OUT WHICH POSSIBLE FUTURE WE MIGHT GET. DAN GRILIOPOULOS INVESTIGATES.

We've had a century and a half of imagining what virtual reality might be. The first pseudo-VR arrived in 1838, with Charles Wheatstone's stereoscope. This produced a 3D image using two splayed lenses and a pair of slightly different drawings (see 'The first VR headset', page 76).

Since then, we've been imagining what could come next. The first fiction to posit something recognisable as VR was Stanley G. Weinbaum's *Pygmalion's Spectacles*, in 1935. It featured a pair of goggles showing "a movie that gives one sight and sound... taste, smell and touch... You are in the story, you speak to the shadows and they reply, and instead of being on a screen, the story is all about you, and you are in it."

After that, our concept of VR stabilised. We knew what it was going to be like, we just had to wait for technology to catch up. Palmer Luckey's creation of the duct-tape-and-prayer Oculus Rift prototype showed us the time had come.

Even now, there are multiple routes where VR may go. Is it going to be *Star Trek's* Holodeck, where VR is headset-free? A totally immersive all-body VR, like *The Matrix*? The parochial virtual universes of Iain Banks' books *Feersum Enjinn* and *Surface Detail*? Are we going to be masters of our own universes, as in *Otherland* and *Ready Player One*, or pawns, as in *Neuromancer* and *Snow Crash*? Let's consider the possibilities...



THE SHORT TERM

At the moment, there are four major options for VR, in decreasing order of impressiveness and price: Valve and HTC's Vive; Facebook's Oculus Rift; Oculus and Samsung's Gear VR; and Google's Cardboard. How are they each likely to improve over the next year or two?

As of this E3, the two big ones don't seem likely to change very much. The HTC Vive launched pretty much as a complete product, tied into the relatively mature Steam VR operating system, with a wide range of games available. Using it, the only thing it really needs is a fix for the blasted 'screen-door' effect, and more powerful graphics cards.

As Epic's Nick Whiting says, "VR represents one of the most demanding computational applications, due to the resolution and framerate requirements. In the game development community, we were still looking at making games that can run consistently at 1080p at 60fps, and then VR upped the bar to nearly 2.5K resolution at 90fps. Add on top of that the fact that we have to render stereoscopically, and the result is that we've had to look back at older techniques, that we used to use in game development, to achieve the effects that we want at the speed we need."

Oculus Rift, on the other hand, launched too early to stay competitive within the Vive's launch window. Though a reasonable software lineup was in place, the core Oculus Touch controllers aren't due to launch until later in 2016, alongside an array of exclusive games. The CEO of Ndreams, Patrick O'Luanaigh, sums it up neatly: "VR is a 5-10-year thing, and we're in Year One."

As O'Luanaigh hints, for both platforms, the games aren't quite triple-A yet. Most games coast on the immersiveness of the tech. The few good experiences — *The Climb*, *The Lab*, *Chronos* and *Eve: Valkyrie* — are single mechanic ideas scaled up into full products; they all feel simultaneously a little small and overstretched, no matter how compelling and impressive the core loop.

Whiting thinks this is down to developers slowly getting to grips with the tropes of the tech. "With the rapid pace of progress on the technical side,

I think it's easy to forget how long it takes to develop the rules for interacting with a new medium; the grammar and conventions. If you look back at early film, it took decades for cinematic conventions to take hold, and they're still evolving. I think we're seeing that same thing right now in VR, albeit at a much faster pace."

What might change that is the entry of the larger publishers into the field, who'll want to be on every platform. Ubisoft already has an *Assassin's Creed* spin-off app that it's demoing, and PSVR is being headed up by an array of familiar faces. As Whiting says, "I think

THE CONSOLES

This year's E3 was a bit of a game-changer for console VR, with both Microsoft and Sony announcing new consoles designed especially to support VR and 4K (although, realistically, few gamers target 4K, even on PCs — 95% of gamers play on 1080p or lower, according to a Steam survey).

The first outing for a console VR system is likely to be the PlayStation VR. That's a pity, because it's the weakest of all the non-mobile VR systems we've encountered. From our time using the headset, it seemed ergonomically very slick, but the demos

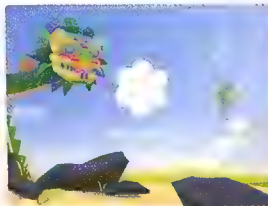
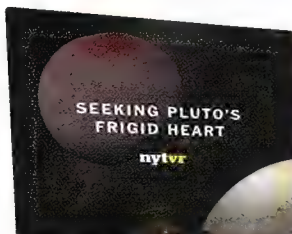
"If you look back at early film, it took decades for cinematic conventions to take hold, and they're still evolving. I think we're seeing that same thing right now in VR, albeit at a much faster pace."

a lot of the traditional funding vehicles, like publishers, were hesitant to start spinning up content teams to create experiences, because they didn't have a firm launch date or price point to try to determine if it was worth the investment. However, now that we're starting to see commercial headsets ship, that's changed."

The addition of cheaper, third-party headsets, such as Razer's US\$400 HDK 2.0, will hopefully increase the market size, too.

didn't throw lots of polygons around. Plus, there were reports from E3 of journalists experiencing 'simulator sickness' on some of the new PSVR games.

So, both firms have recognised the need for better hardware. Sony's more powerful PlayStation Neo (AKA the PS4.5 or 4K) will use exactly the same PSVR as the PlayStation 4. Indeed, reports indicate that Sony is contracting developers to ensure that there are no feature differences for



The eternally improving Google Daydream virtual reality interface.

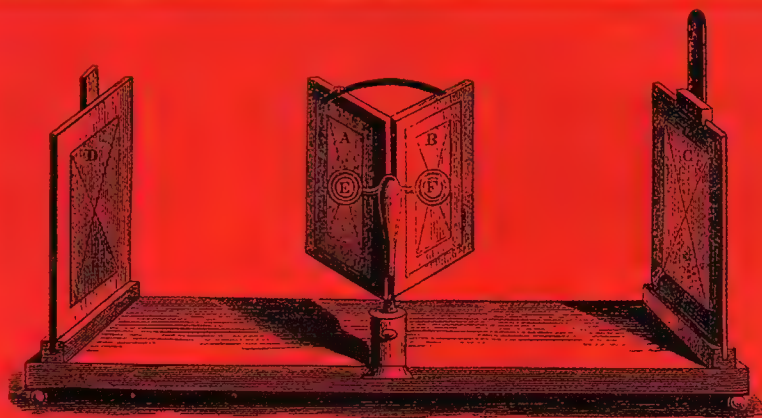
The first VR headset

And the birth of 3D, all in one!

To us, using it today, virtual reality seems a unified idea, a combination of aural, visual and vestibular (balance) stimuli, which gives a convincing sensation of being in a false location. By contrast, the very first thing that looks like VR was the Brewster Stereoscope, based on Charles Wheatstone's Stereoscope.

Wheatstone was one of those 19th-century inventors who seems to have been involved in every invention of his era — electronics, cryptography, telegraphy, spectroscopy, acoustics and so on. To make the Stereoscope, he had to explain binocular vision first, and how it gives the impression of solidity to the world (crucial in VR).

Wheatstone's Stereoscope was less impressive, but established the basic principles of virtual reality. It used different images for each eye, reflected by an individual mirror. However, this happened in 1838, the year before the photograph was invented, so the images were hand-drawn, and could be made very large if required.



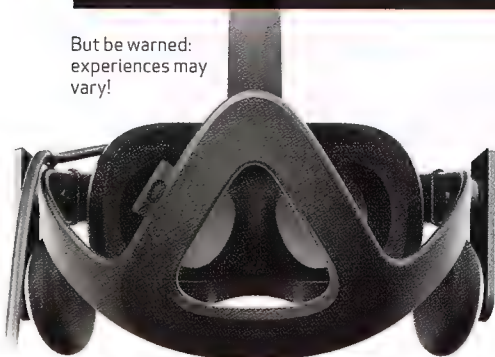
Much like modern virtual reality, each image was slightly different, simulating the different views of an object from the left and right eyes. The brain fused the image in the same way, resulting in what appeared to be a 3D object with depth of field.

Brewster's later lenticular Stereoscope, which looks much like a View-Master, used lenses rather than mirrors for presenting the different images to each eye, and was on a much smaller scale.



Steampunk, eat your heart out!

But be warned: experiences may vary!



games developed for the systems — and no games exclusive to the Neo — so that it doesn't lose its existing user base.

Microsoft seems less protective of the Xbox One, presumably due to its weaker market position, but is still positioning its VR console Project Scorpio as an Xbox One Point Five. It's got slightly more power than the Neo — which it'll need to run the Oculus Rift headset that's widely mooted to be its companion — but still not enough to beat the current best of PC tech, such as the GeForce 1080.

Meanwhile, Nintendo of America's president Reggie Fils-Aimé said, "We've been looking at the VR space since the days of the Virtual Boy. With us, we want to make sure that our next content is going to be mainstream, mass market approachable, and when VR is at that point, you can expect Nintendo to be there." But not right now.

Despite those problems, Whiting and O'Lunaigh are among many who think that console VR has an advantage over PC. The huge install base for the consoles, and the lower price of PSVR compared to the big two on PC, will attract mass market customers.

Whiting thinks there are more subtle advantages to console, too. "You're working with a fixed platform, which takes a lot of the effort of making a VR experience scalable across different hardware configurations out of the equation. Additionally, Sony requires certification for all of its titles, and that helps ensure a quality experience. That's important, because unlike most traditional games, a bad VR experience can make you physically ill!"

O'Lunaigh agrees, "There will be over 40 million PS4s out there by the end of this year, and PlayStation VR is a high-quality, well-priced, plug-and-play

platform that has already had massive levels of pre-orders. I expect Sony to hit VR hard."

THE MEDIUM TERM

More mass market even than consoles is VR on mobile phones. Mobile VR has been mildly popular so far, but O'Lunaigh thinks it'll become truly mass market in the next five years. "I think you will see big improvements to mobile VR soon — in terms of power, comfort/size, control systems, positional tracking, managing heat (so you can play for long session lengths), and so on."

In particular, Google Cardboard has been a massive, successful experiment. By January this year, Google had shipped over five million Cardboard viewers, with over 25 million app downloads. That's a huge number, when estimates of Samsung's (much more expensive) Gear VR shipments are around the 800,000 mark. Google has also been working with HTC on the Vive, shipping the unique 3D oil painting application Tiltbrush for its launch.

Google Daydream is Google's next step in VR, and its bet is still on mobile VR. Daydream and the VR tools to run it will be built into the next version of Google's mobile OS, Android N, and developers are already building software for it. Much like the Gear VR, Daydream is a relatively premium product, built for high-quality,

extended use. It comes with a unique controller that's a bit like a very small Wiimote — its rotation and orientation are accurately tracked, and it has a small clickable touchpad.

Whiting thinks this is crucial. "A big step in the right direction for bringing more serious entertainment content to the mobile platforms is adding a standardised controller. Without a controller, you're very limited in the interactions you can perform in a game. I think that's why you see so many turret shooter-style games on mobile currently."

That said, mobile VR still has bigger problems to overcome, both in software and hardware. "While PC VR is hard, in a lot of ways, mobile VR is even harder!" says Whiting. "You're on a much more constrained platform in terms of performance, and you also have to contend with heat and battery life issues. All that means that you either have to greatly simplify your content, or you have to really put in a lot of effort to making things look great."

THE OTHER CREATIVES

Beyond the hardware, the experiences that are being created will change substantially in the medium term. Because although the first wave of VR kit was bought by developers (mainly indie developers) through Kickstarter, it's been widely disseminated throughout the games industry. With the backing (and money) of Facebook and HTC, Oculus and Valve have given away thousands upon thousands of developer kits to developers. And HTC has just launched a new \$100 million investment fund called Vive X, to "cultivate, foster and grow" the global VR ecosystem.

Yet they're already making other moves. Because all that funding and drive isn't just going toward game developers — the other creative industries are circling and keen to get involved. This could be an excellent outlet for movie creators, desperate to break out of the big-cinema, big production cost loop. One could argue that the natural place for Guillermo Del Toro and Terry Gilliam's feverish creations is in a first-person virtual nightmare.

Some directors are already making the jump. For example, blockbuster film director Michael Bay (*Transformers*, *Pearl Harbor*, *Bad Boys II*) announced in June 2016 that he was working with a new Hollywood studio, The Rogue Initiative, to launch a "gritty, danger-close action, coupled with (his) signature style and storytelling". The Rogue Initiative also brings together management from Activision, Disney and Pixar, and is currently working up at least four movie-style projects for VR. And Oculus has already snapped up



some ex-Pixar folk to make *Henry*, a VR animated short, as well as larger projects.

Whiting sees the trend going further. "Film, architecture and design have all gone in head-first. However, many of those fields don't have a lot of experience in real-time rendering, which presents a significant challenge.

That means we have to find ways to make it easier to technically create visuals at the fidelity they're looking for, without necessarily having them fundamentally alter the way they make content. I think this is why you see so much excitement over techniques like multi-resolution rendering and hardware-accelerated stereoscopic

The simulation hypothesis

Is life just a game where we make up the rules?

"There's a one in billions chance we're in base reality," said Elon Musk, the billionaire inventor behind the Tesla car and SpaceX rockets, and founder of PayPal. Talking at the Recode Code conference, he said he thinks we're almost certainly computer-generated creations of a more advanced civilization's simulation — a video game.

Musk pointed to the advances in video games technology over 40 years, from Pong to "photorealistic, 3D simulations with millions of people playing simultaneously... virtual reality, augmented reality". He pointed out that we're "on a trajectory to have games that are indistinguishable from reality, and those games could be played on any set-top box, or on a PC, or whatever, and there would probably be billions of such computers or set-top boxes, so it would seem to follow that the odds we're in base reality is one in billions."

This thesis was first created by philosopher Nick Bostrom, and is a combination of concepts from two 17th century French philosophers. The first is René Descartes, and his concept of the Evil Demon (*malin génie*). This is the possibility that we're being deceived about the world around us by an all-powerful creator — in this case, a video game programmer.

Then Blaise Pascal's Wager says that, however small the probability is that God exists, the huge threat of being wrong, missing out on heaven and landing in hell, means it's rational to believe in God. Musk turns that into a tiny probability that computers could replicate reality, and a huge amount of time.

Bostrom is less certain. He thinks it's impossible to determine whether human-level civilizations will reach the point where we can and want to run convincing simulations. We don't have any way of knowing whether such civilizations ever get to run these simulations — or whether they want to, if they can. Not that a simulated individual would know.

Nick Whiting is more impressed by the implications of the theory. "The fact that the theory even exists is a testament to our desire as humans to be able to create and play with reality. We've always sought to bend the rules, and harness them for our own progress. That's the ambition that drives scientific discovery, and I think is part of why so many people see so much potential in VR. VR is a world that we can create and manipulate as we see fit, and there's a lot of fun in that!"

Bridging the uncanny valley

Merging motion picture with video games.

One of the biggest problems for VR is overcoming the uncanny valley — the point where human actors need to be much better. Unreal's Nick Whiting has been specifically working on this: "The real magic of VR is in developing interactions with other characters. Because the user is actually a part of the world with VR, developing empathy with other characters is a much more powerful narrative tool than in other mediums if done right."

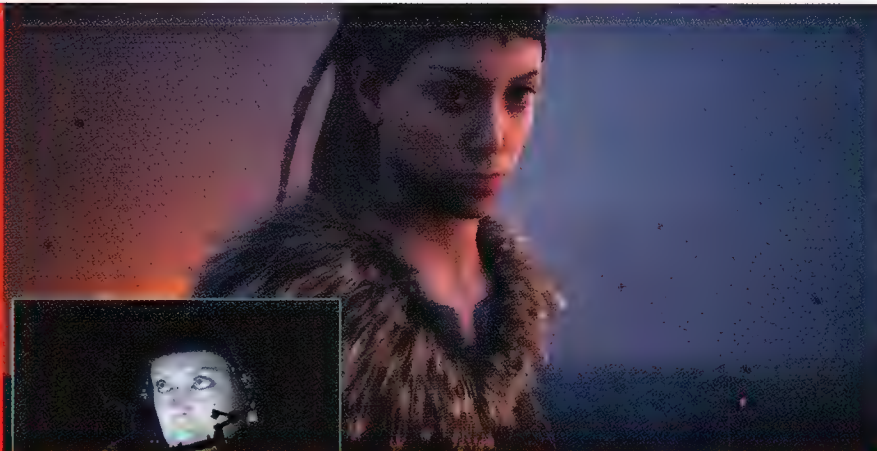
Whiting points to a technique in Neal Stephenson's novel, *The Diamond Age*, that's inspired him to create a solution. "One of the characters interacts with a techno-storybook that creates a narrative around her actual situation. It then outsources actors in a futuristic version of mo-cap suits, to act out the parts for the storybook's virtual characters. I thought this was a particularly neat idea, since humans are way better at acting human than computers! It skirts the uncanny valley by

using real human movement and facial animation. Instead of trying to fake it."

So at this year's Game Developer's Conference, Whiting's firm Epic collaborated with several games companies (Ninja Theory, 3Lateral, Cubic Motion, Kinema and Xsens) to create a demo that used live motion capture data from an actor and fed it, in real time, into a high-quality cinematic.

"That was the turning point, where Neal's vision in *Diamond Age* finally seems attainable with virtual reality.

If you look at the rig used, it's complicated, but all the components will eventually come down in price and complexity, and we can make those sorts of interactions practical for widespread use in VR. Many people dream of the so-called metaverse, but to me, before you can make that a highly compelling social experience, we're going to have to start taking these bits of hardware and technology that can capture the subtlety of human expression, and then broadcast it into a virtual world."



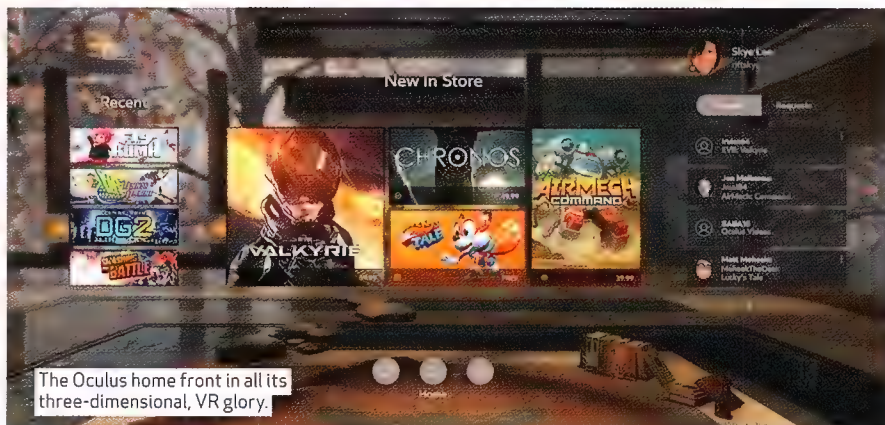
rendering. The more efficient we can make the rendering for VR, the easier it will be to create great content."

SOCIALISATION

The most important element that's missing from current VR systems is also one that the Oculus Rift is perfectly placed to solve: social networks. Already, independent developers are releasing social VR apps, hoping to get the early starter advantage on the big companies. Altspace VR is one such app, that enables users to meet up in chat rooms, and play games with other users. Ruairi Rodinson, a QA consultant and game developer, has been meeting people in it.

"It was very different," says Rodinson. "I've played many MMOs and LAN games over the years, but the simple fact I was making eye contact, and watching people's heads and hands for body language, meant it felt like I was in a room with people. Heck, the fact I could just walk away from the table and talk to someone in the corner, without exiting anything or losing the flow, similar to hanging out in a bar, made it unique." That said, there were social elements that still needed technical fixes. Because Altspace is available on multiple devices, players have a greater or lesser capability to interact.

"Some people got in your space," says Rodinson. "They just stood too close. It felt rude, from strangers."



THE LONG-TERM

The long-term future of VR could go any direction. O'Lunaigh thinks there are still huge technical advances to be made, which will require new great leaps forward in other technologies. "VR display technology that doesn't use screens in front of your eyes — something like virtual retina displays that beam photons into your eye, meaning very small headsets that look like a pair of glasses. This will allow AR and VR to work together, and for users to switch between one and the other. I'd love to see positional tracking that doesn't require external cameras or markers. I'd love to see untethered high-end VR headsets. And I'd love to find a great solution to walking/running on the spot in VR."

We referred to *The Matrix* and *Star Trek* earlier. It's notable that many of these depictions of VR have been negative. The Holodeck was always threatening to escape its bounds, *The Matrix* was about the enslavement of mankind in VR to power AIs.

That probably says more about the apocalyptic imperatives facing science-fiction creators, if they want their novel to be successful, than it does about the possibilities of the technology. But it's true that, because of its immersiveness, VR is something that can be used for good (psychology, doctors, social networks) and bad (torture, propaganda and brainwashing).

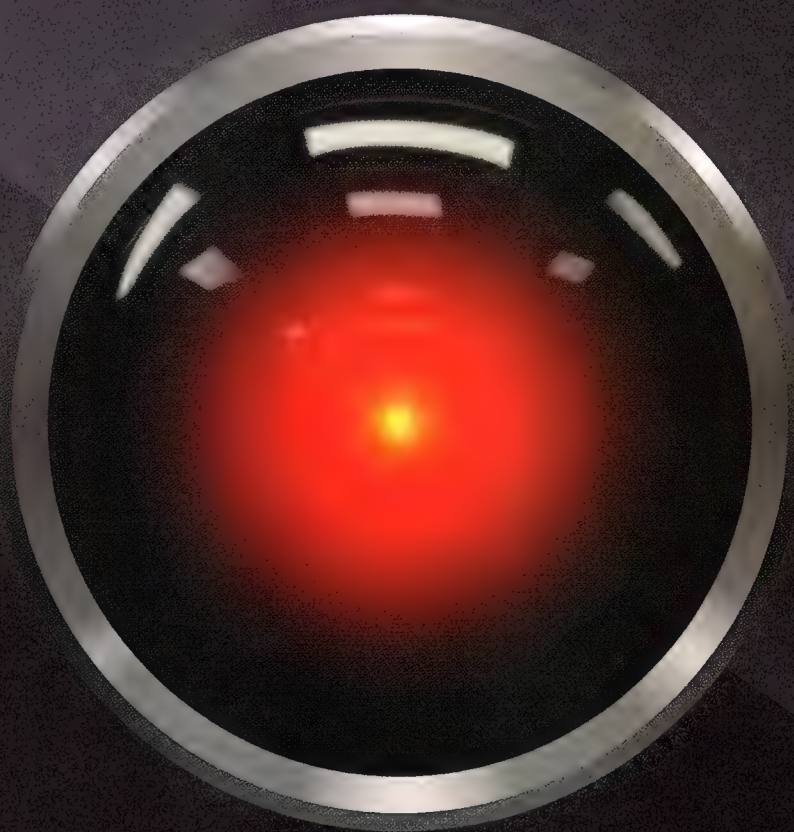
The only limit is the human imagination — and you might say that's no limit at all. ■



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TOMORROW'S AI HELPER, TODAY

MOVIES AND POP CULTURE HAVE ALWAYS DEPICTED THE IDEAL ELECTRONIC COMPANION TO HELP MANAGE YOUR LIFE. SIRI WAS A GOOD FIRST STEP TOWARDS THAT LONG-PROMISED FUTURE BUT, AS DREW TURNEY DISCOVERS, YOU MIGHT BE SURPRISED BY JUST HOW CLOSE THAT FUTURE COULD BE.

Picture this: you leave work and stop at a coffee shop on the way to the bus stop. You've in the queue when your mobile beeps. When you answer, Maia's familiar voice cheerily says, 'Hey, you know if you drink coffee after 3pm you won't sleep, and you've got that early meeting tomorrow.'

Maia isn't your secretary. An acronym for 'Machine-Autonomous Intelligent Assistant', she's your personal artificially intelligent helper.

She knew where you were from the GPS on your phone. Your heart rate and breathing told her you were standing still so she assumed were standing in the queue. Since she knows your medical history, she knows about your afternoon caffeine intolerance, and with access to your calendar data, she knows that meeting is tomorrow. Maia has constructed a picture of your life at that moment from a huge variety of sources, and she talks to you like a friend.

But it's not all about convenience. Imagine Maia knows from your GPS data that you're on a major highway and that you suddenly go from 90 to zero very quickly. She sees that you applied the brakes hard before you stopped. An accelerometer in your car (the same mechanism that reorients your phone or tablet screen based on how you're holding it) reports that the car isn't level. Step one would be to ask if you're okay. If you don't respond, step two would be to summon emergency services with immediacy that might save your life.

Maia might seem like science fiction, but it might surprise you to learn that many of the technologies that might build Maia or something like her are already in widespread use — you hold several elements in your hand every time you use a smartphone.

When it comes to the future of the artificial intelligence we've dreamt about for so long, what if the only thing missing is the systems integration needed to make it happen?

WHAT ALGORITHMS DO

Where HAL 9000 from *2001: A Space Odyssey* seemed far off in 1968, Spike Jonze's 2013 film *Her* — in which an introverted writer falls in love with an artificially intelligent operating system — seems all too prescient. Could we be fooled into falling in love with AI because it's so lifelike? Might we even prefer it to the uncertainty of human relationships? And then how long will it be before scammers use AI to pose as real people, befriend us to empty our bank accounts?

So far, most AI applications aren't designed as personal helpers ('Siri on steroids', as it's sometimes called). Most take advantage of the unique talents of digital computing (remembering numbers and so on) to perform outstandingly well at a single problem. Your antivirus software is very good at stopping threats it's never seen before (more below) but it's never going to forecast the weather — even if both use rudimentary AI in some form.

UNDERSTANDING US

The way humans developed language couldn't be more different from the way we designed computers to do it. Where ours is abstract and messy, a computer imparts information in a strict, rigid form — the tiniest variation renders the information unintelligible.

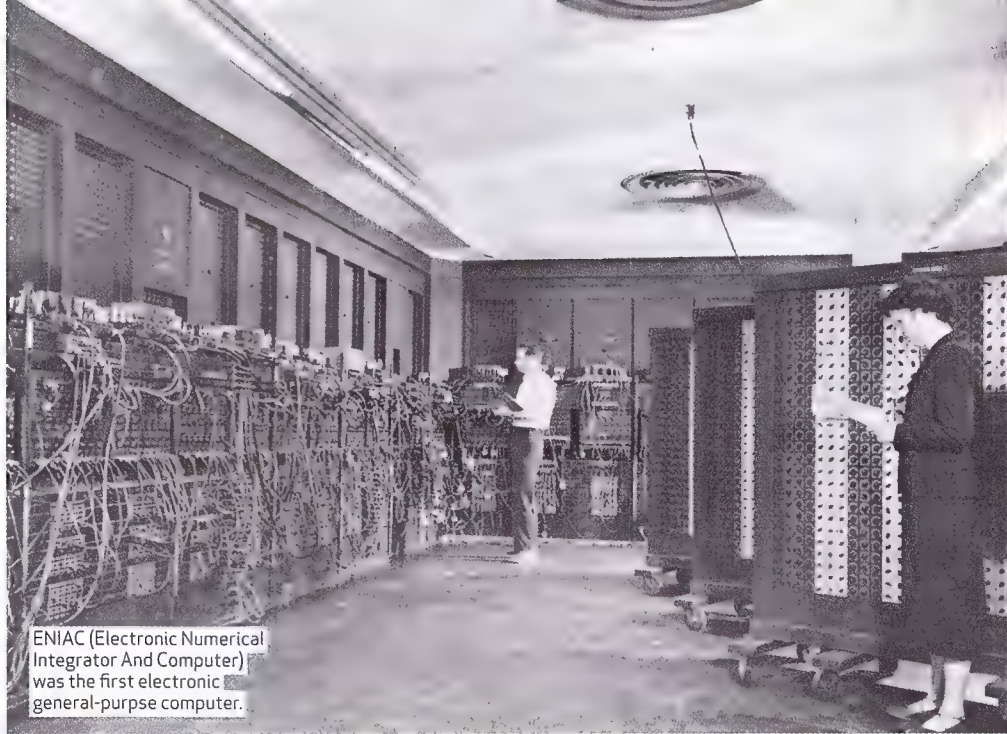
Speech-to-text software has been bridging the gap for decades now. Modern voice applications come pre-loaded with a huge dictionary of words and sentence structures, matching the sound patterns in your words to examples in the built-in library. If you have a lisp and say 'thtate library' and the system has no word that matches it, it'll ask you to input it, which assigns that sound pattern to that word. Next time it hears 'thtate', it knows how the word 'state' sounds in your particular voice, adding to its dictionary and improving accuracy over time.

iOS's Siri does that today, but with a much bigger dataset than just an onboard library. Ask her 'Where's the thtate library?' and she'll have access to countless examples of the same sound pattern matching the word 'state'.

Google is still one of the leaders in the field, launching a neural network product in 2012, which a spokesperson for the company said resulted in a 20–25% improvement on dealing with the wrong word.

MORE THAN JUST WORDS

Most communication between humans is non-verbal. Even forgetting body language for a second, the pauses, tones and a hundred other non-linguistic cues contain a wealth of information software isn't looking for. In 1971, a psychologist coined the 7-38-55 rule



ENIAC (Electronic Numerical Integrator And Computer) was the first electronic general-purpose computer.



IBM's Deep Blue computer beat chess champion Garry Kasparov in 1997.

— percentages of the relative impact of words, tone of voice and body language when speaking.

IBM's Watson, famous for beating a human player at *Jeopardy!*, offers a service called Tone Analyzer, designed to offer feedback on text you write and upload. Programmed to look for emotional and social cues including negative, cheerful, angry, confident, sad and disgusted, it forms the bedrock for a computer interpreting our emotional state by what we write. Combine it with speech-to-text, and it might give the

software an appreciation for our emotional intent when we speak.

Of course, digitised mental-state machines are already widespread. Wearable devices are the first steps in reading the things we don't, or can't, say. They already track a host of 'personal metrics' from the number of steps walked to the quality of your sleep.

Can we be far off a wearable sensor that puts together heart rate, capillary dilation, skin conductivity and other physical giveaways — and then using that sensor to build a picture of how we

IBM's Watson uses natural language processing and machine learning to read our tone through text.



Delivery

In Her, protagonist Theo takes Samantha (through the conduit of his phone) everywhere, and she never fails him.

The reality — even in Australia in the 21st century — is very different. The data generated by constant voice conversations with all our AI helpers will need stronger, more robust networks than we're used to. According to Mindmeld, voice usage has grown from virtually nothing when the company began in 2014 to over 15% of all search traffic today.

A high-speed public network like the NBN shows promise, as will some comparable future wireless network, but when many of us still experience call dropouts in major cities, mobile or wireless networks are going to have to be way better to package and transport such services.

feel (not to mention our real intent when we say, 'Of course, I'll still respect you in the morning!')

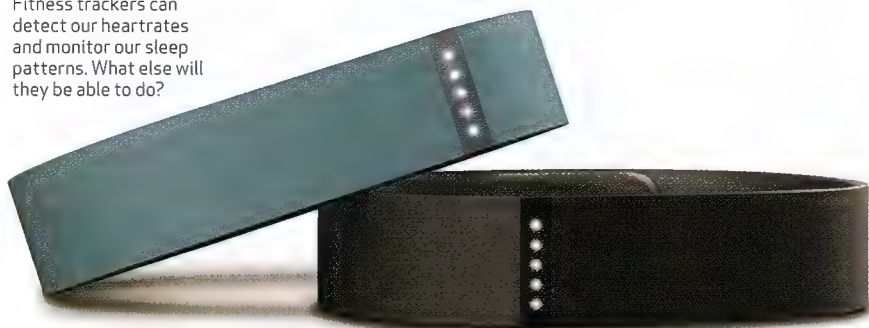
BACKCHAT

Of course, when we talk to a computer, we don't want a reply like 'function (a,b,c){function d(a){var c,d,e,f=b.createElement("style")'

Having AI respond like it was an approximation of a human is a whole separate problem. As described above, the system has to understand the intent of what we've said in order to craft a response. In this case, dictionaries and databases won't cut it — human speech is just too hit and miss.

Enter machine learning, an area that will likely have more of an impact on our AI helper than any other. Has your GPS ever suggested a different route to avoid traffic? It's not using data that someone programmed in, it's interpreting new data available according to rules about its own behaviour — algorithms that let it learn.

Fitness trackers can detect our heart rates and monitor our sleep patterns. What else will they be able to do?



When it comes to crafting speech to respond to us appropriately, it's all about context. A 2013 University of Texas research project called ISOGRAM gives a computer the power to draw conclusions about sentence meaning based on common word associations. If it reads 'the robber was charged', it will find more examples of robbers receiving convictions than of robbers being hooked up to batteries.

Although ISOGRAM wasn't developed to teach computers how to talk, such examples of 'word relationships' let it constantly build on the experience of correct phraseology. And expanding the available data to the entire contents of the web would widen the potential exponentially and form the first step for a computer to construct an appropriate reply.

When Watson won at *Jeopardy!*, it was a different kind of victory than when IBM's Deep Blue beat chess champion Garry Kasparov in 1997. At it's simplest, chess is just maths and probability, but *Jeopardy!* calls for more than just

semantic, factual knowledge. Watson had to understand the spoken prompt and use the semantics of language to construct the right response.

MACHINE LEARNING

The art of machine learning is to program a machine to learn the way a human acts — no easy task, given our talent for abstracts.

A biological knowledge system (like your mind) wields an incredible array of elements, all of them solid enough to ensure you do a pretty good job surviving in your environment. The brain works by recognising patterns. If you hear a sentence but don't know the specifics, you probably have enough information and experience to put two and two together.

Computers are pattern-blind — they need an exact example of what they're looking for. But a good example of machine learning can be found in antivirus software. Needing to know exactly what to guard against makes it tricky when programmers constantly rewrite bugs so they don't look like older nasties.

In 'flat' computing, a single difference in the code of the virus would be enough to get through, so we program some room for error. If a virus can be expressed as '12345', the antivirus software can be told to treat a process containing '12354' as suspect, flagging it for further checking. It's called heuristics or experience-based programming. Given a little 'wiggle room' in what it needs to identify, a computer can appreciate nuances that aren't hard-programmed in, and as that

experience builds, further wiggle room gives it a body of knowledge that's been 'learned' in the traditional sense.

Today, heuristic programming is used in everything from optical character recognition (OCR), to credit card fraud protection, computer-generated armies in movies and games, and designing train timetables. It finds a natural home in a field called 'sentiment mining', which aims to take the temperature of feeling among a given topic online. Where other text-based big data schemas will just search for keywords or phrases, sentiment mining accounts for the human variables that reveal feeling — idiosyncrasies ('loooooove you' rather than 'I love you'), misspellings, alternative social use ('you kill me'), booster words ('totally love that') or words that don't appear in many formal dictionaries ('amazeballs').

Give an AI agent a big enough body of such experiential data (again, like the entire web) and it will be able to talk back in two crucial ways — informally, and at the usual speed of human communication.

Of course, there's always the chance of false positives. Your antivirus might block a legitimate program, or Maia might say, 'You're at the coffee shop? Careful — remember the time you tripped over.'

But when a friend says, 'I absolutely went to town!' and you say 'Really, did you drive or catch the train?' and laugh, it's clear human communication is full of such quirks, yet we still co-exist just fine. In fact, brandishing such talents for discerning the optimum from variables might be the very definition of 'intelligence'.

MACHINE LEARNING APPLICATIONS

As machine learning techniques mature, they're being applied to more problems and industries all the time.

- A deep learning system (a subset of

machine learning) in Israel is looking at X-rays to identify pathologies, taking some of the burden off overworked clinicians who don't want to miss something important.

- A news service in Chicago uses algorithms to repurpose statistics and facts in raw form into narrative-driven news stories.
- A Georgia Tech research project involves an automatic video-editing algorithm that analyses video for images with ideal artistic properties (geolocation, composition, symmetry, colour vibrancy) to determine what's important or picturesque, and then assembles it into a final presentation automatically.
- A University of Pennsylvania study looked at 28,000 domestic violence cases and enabled the computer to 'learn' who was more likely to re-offend, giving judges a far better idea of who to detain in the initial arraignment.

KNOWING ME, KNOWING YOU

One of things that makes our friends and loved ones so special to us is how well they know us. One aspect of an AI helper like Maia that will be crucial is that she knows your preferences, inclinations and personality.

Here's the exciting (some would say scary) thing — a computer has the opportunity to know more about us than any human. As long ago as three years, it was determined that 90% of the data humanity had produced in our entire existence had been generated in the previous two years.

That's an awful lot of information out there about you. Called everything from your 'social graph' to your 'digital DNA', it's not nearly as segmented as information in real life. While your mother knows you love cheesecake, she doesn't know what adult websites you might have visited, but both facts

about you exist online in the form of an Instagram post about your last cheesecake and your last purchase from Red Hot Video Inc.

An AI agent with access to all that information will be able to put together an astonishingly detailed, real-time and constantly evolving profile about you. Maia won't just speak to you, you'll tell friends with giddy excitement that he/she really 'gets me'.

Even more surprising, the technology to do so predates many of the others mentioned above. As far back as 1995, Amazon CEO Jeff Bezos explained how he was in the business of online shoppers' data — selling books was just a way of collecting it. The model created the first ever recommendation engines, where a website suggests something else you'd like based on a past selection. Amazon made headlines in 2014 with a patent for 'anticipatory shipping', sending you something before you even know you want it, but consider the scenes in her when Samantha leads Theo (while blindfolded) to a slice of pizza and sends his book to a publisher without asking him. In both cases, it's because she knows him well enough to know what he really wants.

MAKING IT ALL ABOUT YOU

After our experience with AI through art and culture, we might respond to it with terror, thinking that it's come to overthrow us — the list is long, from *Frankenstein* to *The Matrix*.

It's in the commercial interests of the companies who produce our tools to have us love them, and they spend considerable money and effort designing and focus testing their appeal. To do that, they're unwittingly hijacking a particular quirk of human nature — research has shown that the same brain circuits are involved irrespective of whether the object of our affection is human or inanimate.



The role of fiction and culture

Even if the technology exists today and we figure out how to put it all together tomorrow, it's easy to forget about the extent to which movies, TV, books and popular culture 'prime' us for possible worlds.

For something to catch on, it needs more than technical feasibility, just ask the makers of the Apple Newton, WebTV or the Rabbit Phone, variations of which are all hits today despite failing in their time.

One of the most distinctive elements of Steven Spielberg's *Minority Report* was the scenes of Tom Cruise assembling evidence from images and video by swiping and gesturing on a giant heads-up display. Was it a mere coincidence tools like the iPhone and iPad popularised swipe interface in the mainstream?

"It's in the commercial interests of the companies who produce our tools to have us love them, and they spend considerable money and effort designing and focus testing their appeal."

her used the husky tones of Scarlett Johansson, but an even better way is to use the voice of someone you already love — a spouse, child or even someone who's no longer with us. Add it to the concept of an AI familiar with your social graph and you have ready-made facsimile of a real person.

In talking about her, futurist and AI expert Ray Kurzweil wrote: 'Jonze introduces another idea ... AIs creating an avatar of a deceased person based on their writings, other artifacts and people's memories of that person'. As more recordings of our voices find their way online in YouTube videos, podcasts or Skype voicemail messages, there's a ready-made record an AI can use to 'build' a virtual copy of our voice.

And as you might expect, voice cloning is already a nascent industry. Services exist that let you produce dialogue, speeches, game content or presentations spoken in custom voices. Build all that into a robot and a beloved, long-dead grandma might bring you soup and chocolate when you're sick in bed. Though robotics is a whole other engineering problem from AI (which is software-based), it's only going to make AI more relatable for us, thanks to our tendency to anthropomorphise.

PULLING IT ALL TOGETHER

Exactly how speech recognition, fuzzy logic response programming and

detailed personal information will interact to build Maia isn't clear. Maybe the principles that form the individual parts themselves will be recruited to design a blueprint for them to work together.

Where it will happen is an easier question to answer. Aside from the very real access and privacy concerns, cloud computing means software and data can connect together to form systems that are more than the sum of their parts like never before. Think of big data sales analytics, which synthesises information from multiple sources to identify new markets no human operator could ever find.

Before the web age, there wasn't much data available and it was cumbersome, slow and expensive to connect together. It's also going to take a lot of distributed computing power — the old days of the standalone PC would never have cut it.

Maia's natural home will be among the power and wisdom of both clouds and crowds. The internet is the biggest network that's ever existed. Every system connected to the network will be its RAM and hard drive, and the websites and apps of the world will be conduits into the machine brain.

Even then, not all the computation need happen in real time either, which will make an AI software agent even faster. As the AI gets more experience, many of the appropriate responses and

actions will already be on hand somewhere for the system to merely pluck out and execute, just like an adult constructing sentences after a lifetime of word use.

The processing will decide what to do next by mapping inputs to outputs according to a massive connection matrix. Using the software in real time takes much less computer power once the off-line analysis creates the data.

THE PRIME MOVER

All it might take is a 'brain' to put it all together, and we have a model for that, too. In 2014, Cornell University developed Robo Brain, a system that downloaded and stored a billion images, 120,000 YouTube videos and 100 million how-to documents and appliance manuals. Why? When robot helpers become standard, they'll have a library of knowledge they can refer to with ease and speed to carry out the tasks we assign them. Couldn't a similar digital information clearinghouse form the executive-level cortex of the AI helper as it trawls the online world to maintain and inform itself?

Cybersecurity gives us another example. Many antivirus software providers now contribute to a huge database of known threats. As the database grows, the 'story' of a computer virus takes shape, letting vendors figure out what havoc it will cause and how similar it is to an existing threat faster and more accurately, letting them get ahead of the situation and issue defenses faster.

RIGHT AROUND THE CORNER?

All of which prompts the question, when? Getting the technologies described above to work together seamlessly is a must — nothing will shatter the illusion of a human-like AI helper like having his/her dulcet tones interrupted by a canned recording saying 'An unknown error has occurred, code 17199'.

When AI helpers will arrive depends on who you ask. Tim Tuttle, CEO of natural language interface provider Mindmeld, says that, while rudimentary applications are already all around us, such all-encompassing, self-contained AI software agents are unlikely in the next 30 years.

But Gary Clayton, former chief creative officer for Nuance Communications (the company behind speech-to-text application Dragon Naturally Speaking) and currently a Silicon Valley investor and advisor, told an Australian science magazine that a guess of even 10 years might be a little conservative.

Whichever is true, and whether it's Samantha, Maia or HAL 9000 reading this, we're eager and a little bit anxious to meet you. ■

how to

» QUICK TIPS

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APC and its readers can be one giant helpdesk. If you have a technical problem, chances are one of us can solve it.

HARDWARE

TIMING IS EVERYTHING

I have two monitors and one needs coaxing into working — I think the issue may be Windows-related. EVGA cannot help me. My primary display is an HP LP3065 linked to a high-end PC through the only DVI port on an EVGA GTX 980 SC ACX graphics card. This monitor runs at 60Hz. The secondary display is a Novatek 563D running at 75Hz. My main view is limited to the primary screen (for games, for example), and set to extended in Windows' settings.

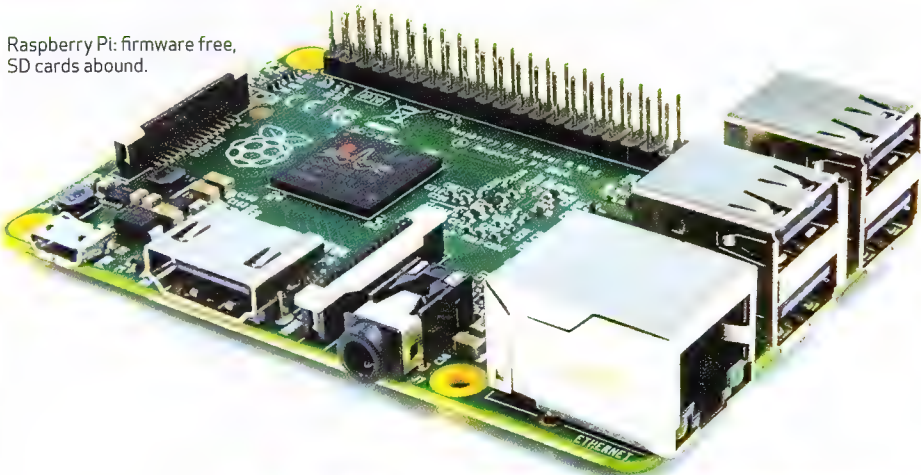
Here's the rub: the only way my secondary screen shows up is if I power it off and only switch it on manually during boot-up, specifically when POST has started counting down. If I do a conventional restart, my second screen would simply not fire up at all, unless I switch off the secondary monitor and wait for POST to take place and then switch it on — mid-POST. The second monitor is connected by way of an HDMI/RGB connector, by the way.

Albert Swanepoel

Do you mean the second monitor is using an HDMI-to-VGA adaptor? Some older monitors and TVs mislabel the VGA port as RGB, but RGB would more usually refer to component video connectors using RCA or BNC plugs. You can't be using this because there's no way to go directly from HDMI to component video without some kind of powered converter box. We also know your monitor isn't really a Novatek 563D, because there's no such thing. Novatek make the driver electronics for LCDs, not the monitors themselves, but some older monitors still get misidentified as Novateks. So, from all that, it sounds like you have an old monitor on a VGA connection.

We're not completely surprised this isn't autodetecting. Your graphics card will only put a signal on the VGA pins during the 'video detect' part of the POST and if the monitor isn't actively listening on the VGA port at that point, it will assume it isn't connected to anything. If you don't want to perform this little dance every time you reboot, you'll need to get a monitor that supports an HDMI connection directly.

Raspberry Pi: firmware free, SD cards abound.



"The Raspberry Pi doesn't have any firmware on the board itself. Everything that it needs to boot must be on the SD card."

Most monitors come with HDMI connections.



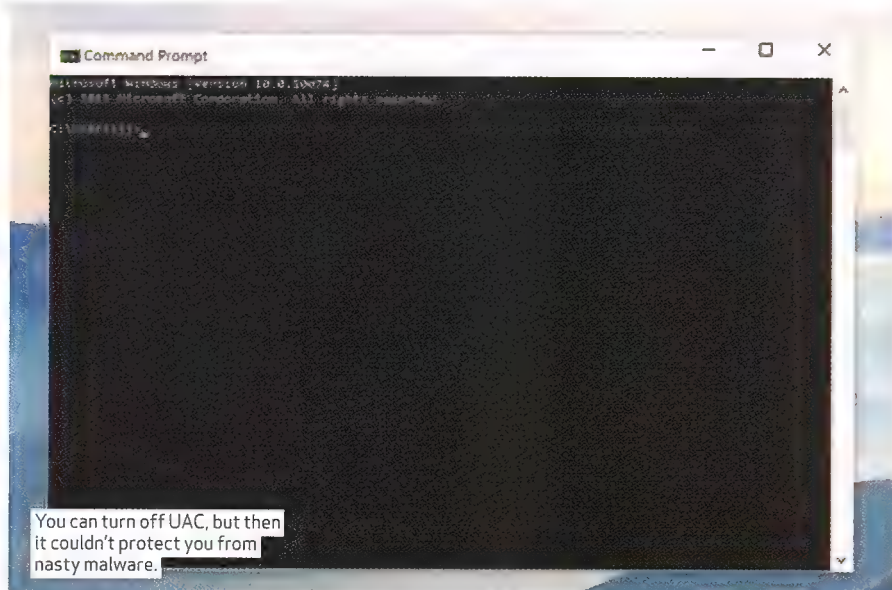
Fortunately, that covers just about every monitor you can buy now.
Luis Villazon

RASPBERRY PI LED BALLOON

So, the other day, I was trying to boot my Raspberry Pi 2, but a very strange thing happened. When I plugged it in, it wouldn't boot, and the lights were solid. I read online, and found out it was an SD card problem. This is funny, because it used to be fine and the SD card is the one that came with my Pi. What SD card will I need

and how big should it be?
Cal Jackman

The Raspberry Pi doesn't have any firmware on the board itself. Everything that it needs to boot must be on the SD card. If it can't read that card, then basically all you have is an expensive LED. The red power LED is supposed to be on all the time. If it



blinks even for a moment, that indicates that the voltage has dropped below the minimum 4.75V the Pi needs. If this happens during the initial boot, the process will just halt there. (Models older than the B+ don't have brownout detection circuits and the power LED just indicates that you have some power – you'll need to measure the voltage between TP1 and TP2 on the board with a multimeter to confirm that you have enough). If the voltage is good, then your SD card has been corrupted. The card itself is probably fine; you likely just need to reformat it and re-download the firmware. The easiest package to use is the aptly named NOOBS, which will fit on a 4GB card. You can get it from www.raspberrypi.org/downloads.
Luis Villazon

WINDOWS

AUTO ADMINISTRATOR

Why does the Windows command prompt not automatically have admin privileges, even when my user account is logged in as administrator? The only time I open a command prompt is when I want to do something admin-ish and it's really annoying to be told that I don't have access or whatever and then have to open a new command prompt with the 'Run as Administrator' option. Microsoft, why you do this?

Tony Whittingham

Because it's a security hole, basically. User Account Control (UAC) is designed to prevent processes from acquiring admin access without you explicitly authorising it. So, if you could open a command prompt with admin privileges, so could malware. That said, if you don't care about that at all, you can turn off UAC (search Control Panel for 'UAC' and drag the slider to 'Never notify'), but we don't recommend it. A slightly safer option is to make a

shortcut for 'windows\system32\cmd.exe' and put it on your desktop or somewhere. Right-click this shortcut and click 'Properties > Shortcut > Advanced' and tick 'Run as administrator'. Now you can double-click this shortcut if you want to start with elevated permissions, but malware won't be able to do the same thing without knowing what your shortcut is called.

Luis Villazon

HARDWARE

ARE DESKTOPS POINTLESS?

Is there any point to buying a desktop computer now? I can get a decent gaming laptop with an i7 processor for about \$2,200 and it will take up a lot less space than a desktop. Apart from maybe some saving in price, is there any advantage to a desktop PC, or are they on their way out?

Jonas Mack

Well you might as well say, "apart from going faster, what's the advantage of a car?" A desktop can be easily upgraded, runs cooler for a given clockspeed and

is more convenient to use with an external keyboard and monitor. But for the middle of the performance bell curve, price is the biggest advantage of a desktop PC. At the very bottom, a netbook is the same price as, and probably superior to, a budget desktop. And at the top end though, you will always get the highest performance from a desktop PC.

I don't know if that will always be true though. I can see a day coming when desktop PCs simply won't be a thing you can buy, much like no one buys a hi-fi anymore. (Kids, if you don't know what a hi-fi is, go and ask your mum or dad.)

Luis Villazon

HARDWARE

LAZARUS' PIXELS

Is there any truth to those dead pixel cures that appear in how-to guides on the web? I'm talking about the ones where you rub the screen with a pencil eraser or flash that area of the screen rapidly using a special program? I have three pixels on my screen – two are stuck on red and the other one is dead (ie. black). Is there anything that can be done about them?

Andy Marshfield

We'll be honest here: we're not entirely sure. We've seen lots of guides that promise to fix dead or stuck pixels, but we've never seen it succeed ourselves and we've never been persuaded that there is a plausible mechanism either. The least plausible are the software-only fixes. These, we're sure, are pure snake oil. If flashing stuck pixels on and off cured them, then stuck pixels wouldn't be a thing in the first place, since flashing on and off is what pixels do in normal use. The pencil eraser technique at least offers the hope that it might schmush some of the liquid crystal into tiny gaps, but it suggests that stuck pixels are caused by air bubbles and if that was the case, you would expect them to sometimes hit



Can you really fix stuck pixels by massaging them? We're not convinced.

"Training manuals for IT technicians explicitly advise against this technique in case you damage the screen further."

several pixels at once in a blob. This doesn't happen; pixels always die in isolation, regardless of the resolution of your monitor. We also can't find any reputable scholarly source that recommends this. In fact, training manuals for IT technicians explicitly advise against this technique in case you damage the screen further.

We had a monitor with a single stuck red pixel though, so we decided to test this for ourselves. If we break a monitor in the interests of science, that seems like a fair price to pay. But here's the thing: when we booted that PC just now, the pixel was nowhere to be found. We tried setting the desktop background to white, black and green – it made no difference, definitely not there. So we fired up Kerbal Space Program because this is where it's most noticeable. And verily, it reappeared. So it looks as if, in this case at least, the stuck pixel is partly heat dependent. Turning the monitor off and back on again gets rid of the dead pixel for a few seconds, and so does applying an ice cube to it. When it comes back, it is initially faint and flickery, becoming brighter over time. Blowing it with a hair dryer makes it brighter, quicker.

What didn't make any difference, at any temperature, was rubbing it with a pencil eraser. Or any of the other supposed cures. Our hunch is that a lot of the reported successes with these techniques were really just the monitor cooling down at the same time.

Luis Villazon

HARDWARE

THE CASE FOR CASES

I'm building my own PC, which will be mainly a gaming rig for things like *Witcher 3* and *GTA V*, so I'm going for performance. I'm happy with my current list of

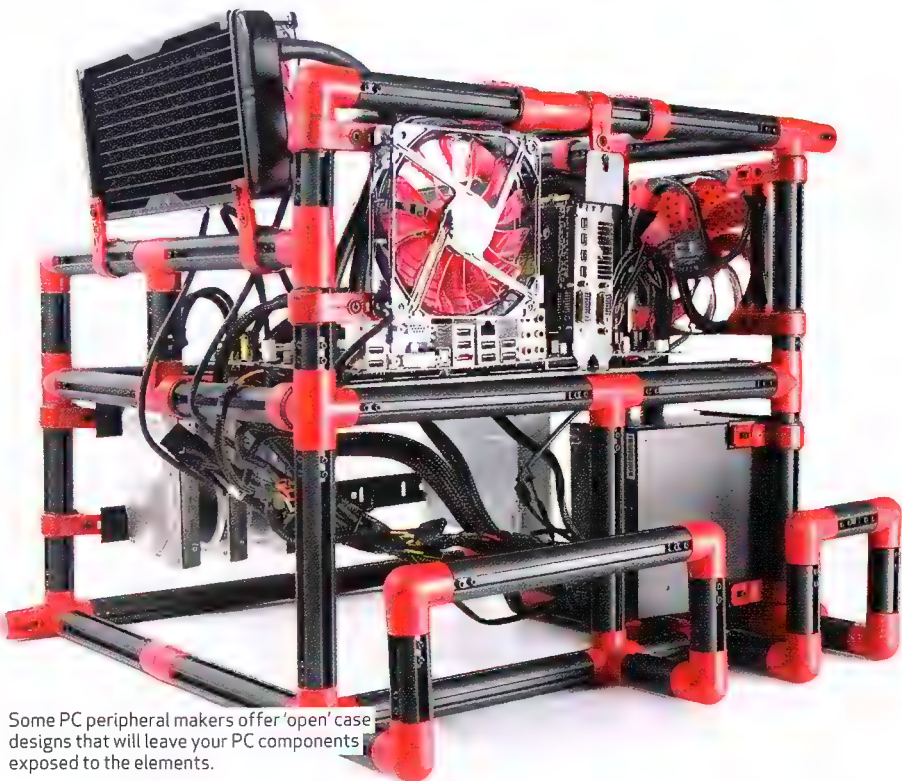
components [long, boring list snipped], but I'm not sure what case to get. Do I actually need a case at all? The CPU and GPU have their own fans already, so surely I'll get better cooling just by leaving the case out altogether?

Dane Harris

Absolutely. Even a really good case will always interfere with cooling a little bit – that's why a good first diagnostic test for an overheating PC is to try running it with the case off and see if that helps. The case is mainly a convenient place to hang the power

button and a way of keeping the cat from jumping on the motherboard. I have an old laptop that I dismantled and mounted on a piece of driftwood on the wall – all the daughter boards are connected with long ribbon cables and it all still boots. If you like the industrial aesthetic, a caseless PC is perfectly feasible and it makes it easier to keep an eye on the dust build up. You'll need to mount it on a shelf out of the way though. Alternatively, there are many vendors that sell 'open' PC cases, too.

Luis Villazon



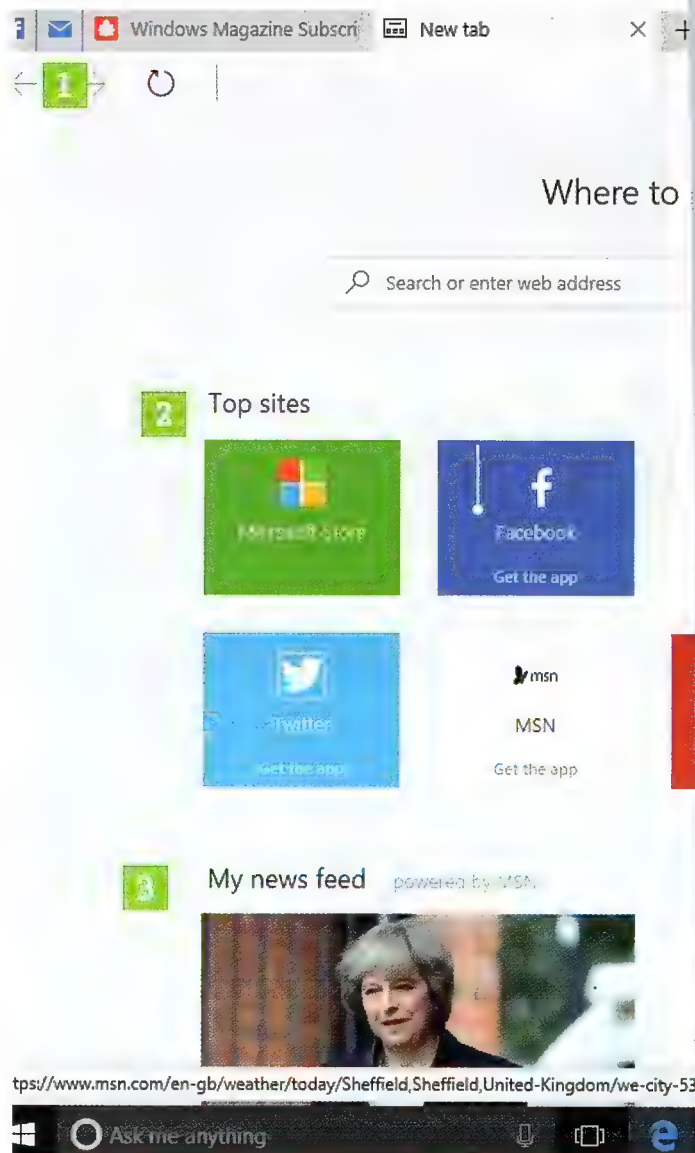
Some PC peripheral makers offer 'open' case designs that will leave your PC components exposed to the elements.

Master Windows' updated Edge browser

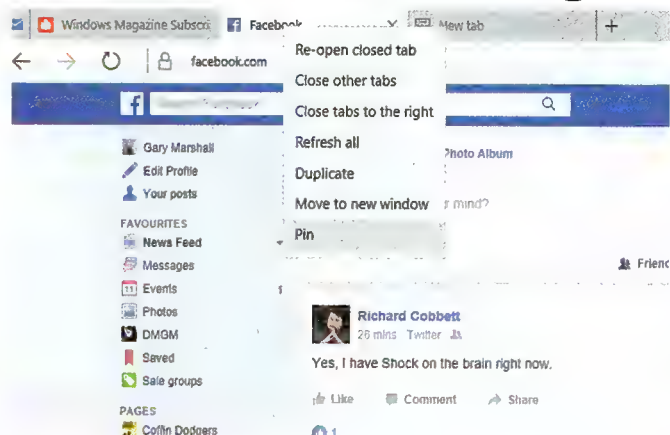
With the recent Anniversary Update, Edge has finally been given the care and attention it deserves. Gary Marshall explains.

Previously, Microsoft's Edge browser could often be a disappointment – it felt clunky, it lacked key features that rivals offered and it seemed a little unfinished. That's changed with the Windows 10 Anniversary Update. You can pin favourite tabs, block annoying ads, install extensions to give Edge extra powers and swipe a laptop trackpad or touchscreen to navigate, and it's more powerful and energy efficient than ever.

A few of Edge's new features aren't available until other people catch up – so, for example, Windows Hello will enable biometric authentication for websites, but for that to work, you'll need a PC with biometric sensors and websites that have enabled Windows Hello. That's all in the near future, but there's still lots of great stuff to get to grips with right now. Let's see what the Anniversary Edge has to offer.

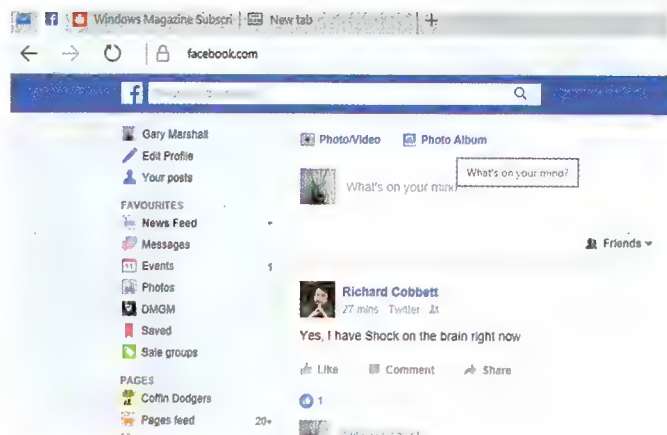


What's new in Edge for Windows 10



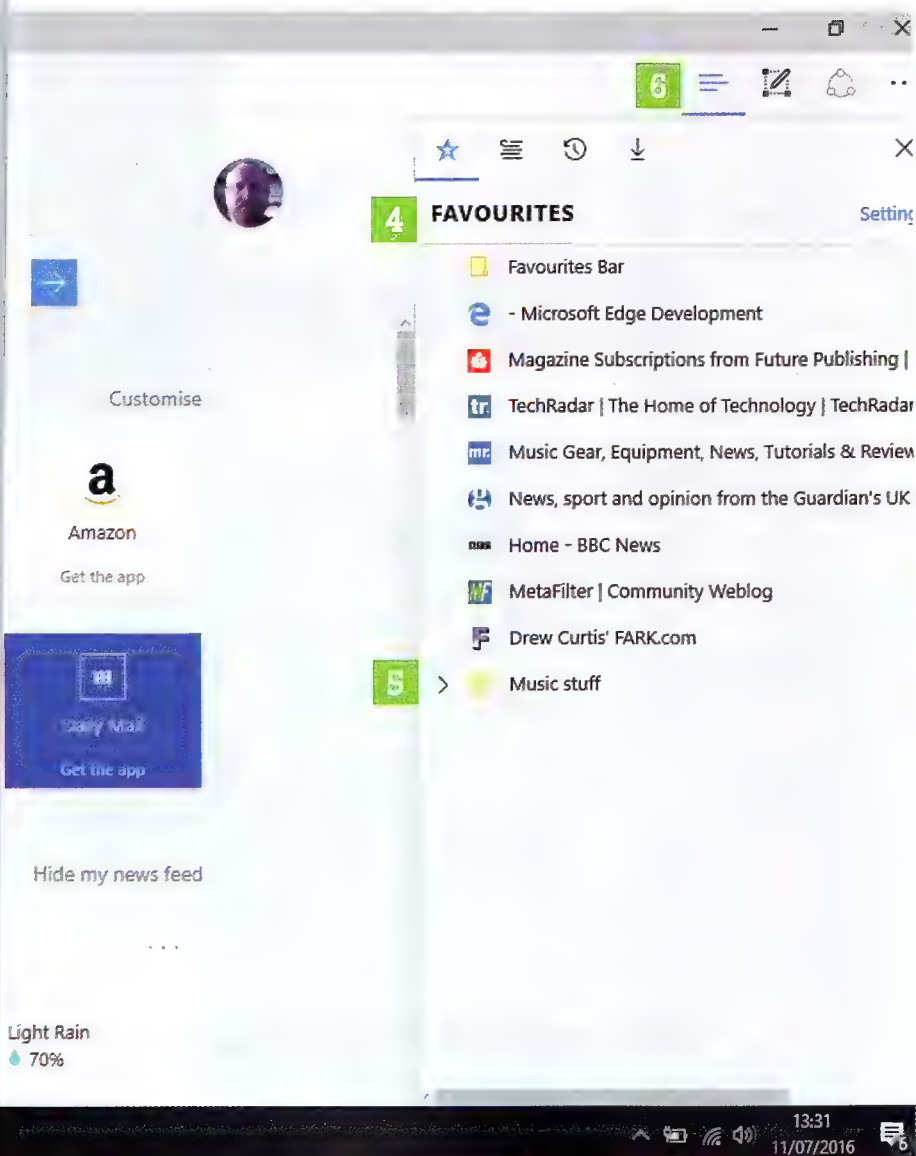
1 PIN YOUR TABS

If you've used a recent Firefox browser, you may know about the joys of pinned tabs, which enables you to turn the current web page into an icon at the top corner of the screen. It's useful for online services such as social media, web-based email and so on. Now Edge offers the same thing. To pin a tab, right-click on the current page's tab and then click on 'Pin'.



2 PLAY WITH YOUR PIN

If you look up at the top left hand corner of the Edge window, you should see the icon for your newly pinned tab. It'll appear in every browser window, although it won't open until you click on it. The icon will be the same as the site's favicon, which is the icon that appears in history and favourites. If you want to unpin a tab, just right-click over the icon and choose 'Unpin'.



1 PINNED TABS
Pinning a tab in Edge turns it into an icon you can use to get one-click access to your favourite sites and services.

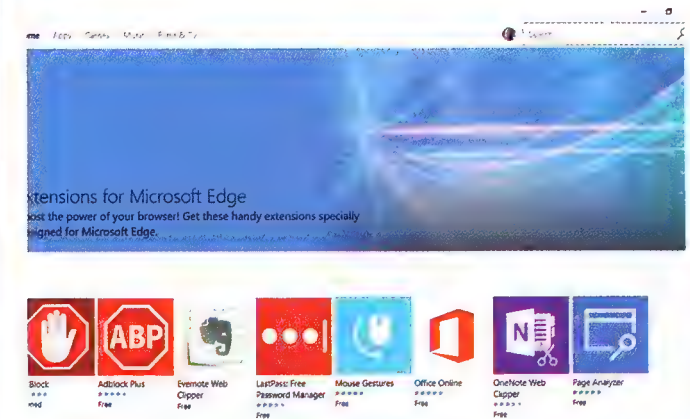
2 TOP SITES
Edge automatically recommends the sites it thinks you might want to see. You can remove any ones that you don't want.

3 NEWS FEED
Microsoft's MSN news service provides an up-to-date feed of the day's top stories, like the MSN start page of old.

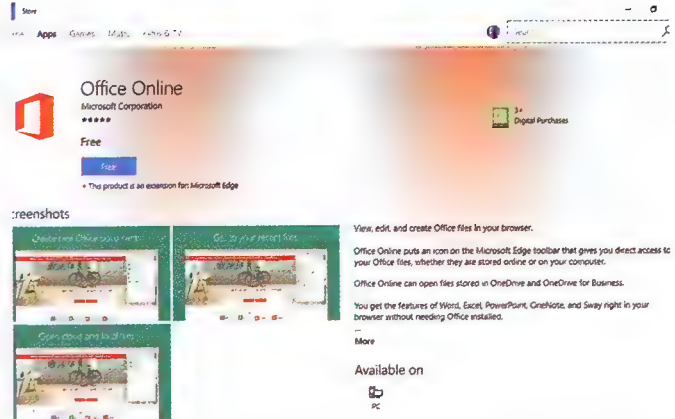
4 FAVOURITES HUB
This provides quick access to your favourites, reading list, browser history and the browser's download queue.

5 ACTION ICONS
In addition to the icon for the hub, Edge has icons for web clipping, for sharing and for changing browser settings.

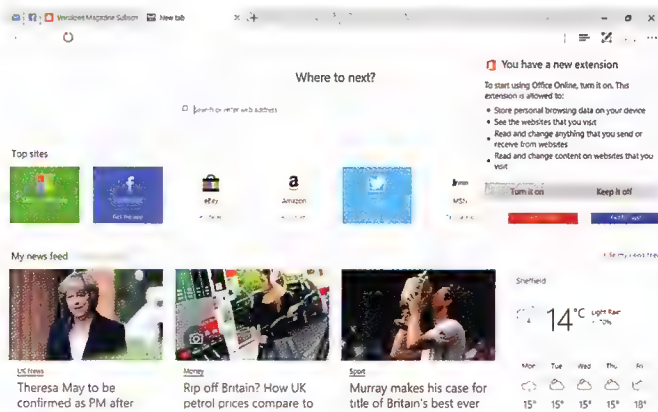
6 FAVOURITES FOLDER
Use Edge's tree view to expand and collapse folders of Favourites — handy for bookmarks.



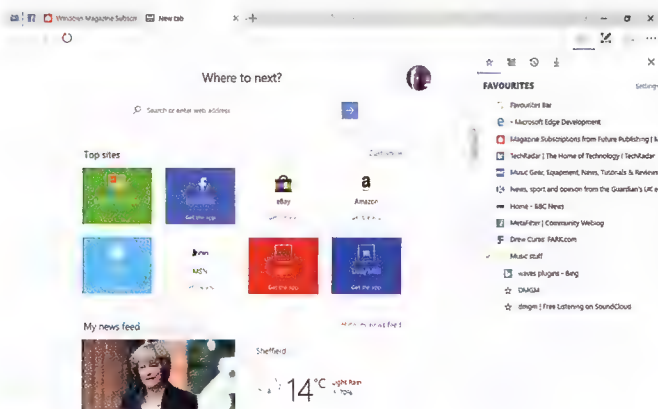
3 INSTALL SOME EXTENSIONS
We're fans of browser extensions, which enable you to give your browser extra powers to do things or block content that you don't want to see. The lack of extension support in Edge was a problem, but not anymore — there's plenty of Edge extensions. To see them, tap on the 'Settings' icon and choose 'Extensions'. That takes you to the appropriate bit of the Windows Store.



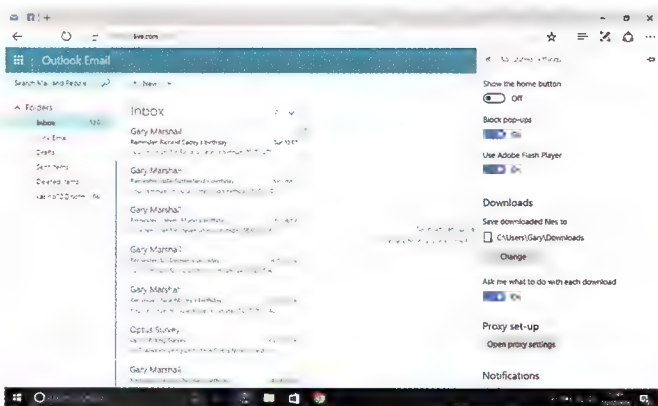
4 CHOOSE YOUR WEAPON
Installing extensions from the Windows Store is just the same as installing anything else from the Windows Store — you get a description, an age rating, a couple of screenshots and a blue button to start the installation. In this example, we're going to go for an extension that adds Office Online to the Edge browser for faster access, so we'll just click the blue button.



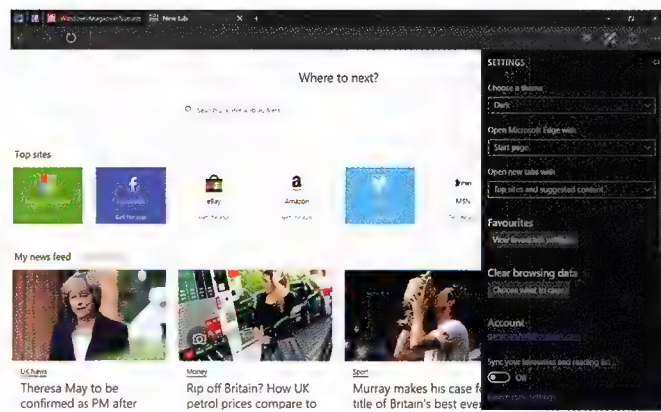
5 TURN IT ON Once you've installed the extension, Windows will take you to the Edge browser to tell you what you've got and ask whether you want to switch it on. With an extension such as Office Online, you're safe, but read this bit carefully with third-party extensions as it tells you what data it can access and what it can do. Bad extensions aren't common, but the odd one may slip through.



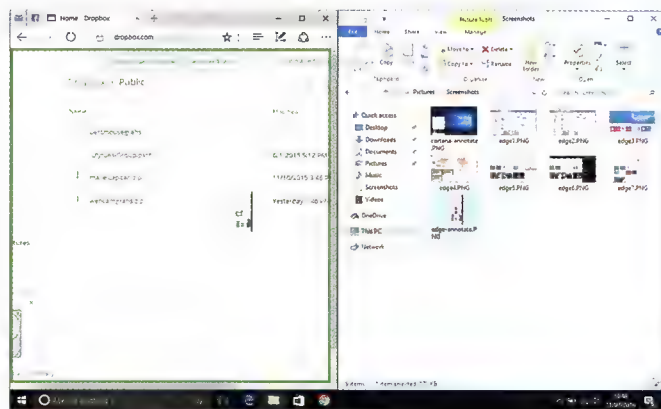
7 AT THE HUB If you look at the top right of the screen, you'll see an icon that looks like three rows of text. That's the hub, which enables you to see your Favourites, clip bits of web pages for later use, share web content or change Edge's settings. Expand and collapse folders so you don't have all your Favourites on screen at once, and you can switch to the reading list, history or download queue.



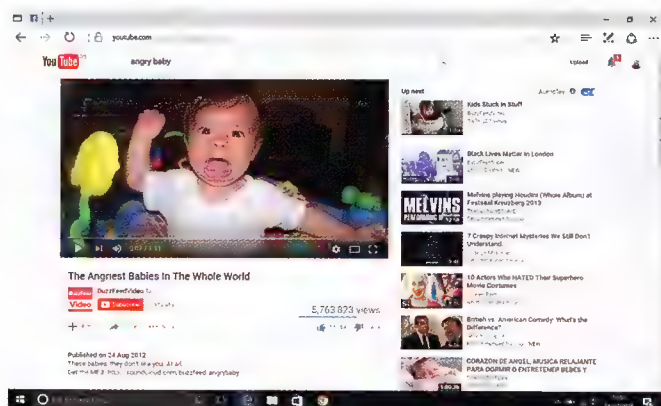
9 DECIDE WHAT TO DO Edge's advanced settings menu enables you to block some of the internet's more irritating features, such as pop-up adverts, and you can disable Adobe's Flash Player too. That's worth doing as Flash is often a security problem due to vulnerabilities, and because some sites often use Flash for autoplay ads. You can also change the default file download location in this menu.



6 THE DARK SIDE The Windows 10 Anniversary Update introduced a new dark theme, and Edge gets the option too — so you can have a dark system and a light Edge, or you can have a light system and a dark Edge. It's important to note that the theme only applies to the 'browser chrome', which is the bit of browser around a website; web pages will still be displayed as their designers intended.



8 DRAG AND DROPBOX If you use a cloud-based file service such as OneDrive or Dropbox, you'll know how handy it can be to store stuff in the cloud, and with Edge, it's easier than ever — if you log into your chosen file storage service, you can add files by dragging them straight from the File Explorer. That's handy if you don't want to install the services' automatic syncing software to share files.



10 DON'T MISS A THING Edge will disable autoplay video, replacing it with a click-to-play version, which should mean the end of being taken unawares by an unexpected advert kicking off for no good reason — such ads won't play anymore. Your favourite YouTube clips, won't be affected, though. The only people who should be worried are the creators of unwanted autoplay adverts ■

Toggle Excel settings

Helen Bradley explains how turning settings on and off with VBA is a cinch with toggle macros.

Download the macros for this story at www.apcmag.com/magstuff.

Many Excel settings have two states — on and off. You can easily switch between the two using a single line of code. But what happens when the available states aren't 'on' and 'off'? Also, what if you want to toggle multiple options at once? This month, we look at toggle routines in Excel VBA.

TOGGLE SIMPLE BOOLEAN STATES

Some Excel properties are limited to being set on or off. These are Boolean states, represented by True and False. You can easily toggle these using a macro by simply inverting the current state. For example, this macro flips the current state of the Excel option that controls display of zeros in a worksheet, saving you a lengthy trip through the Excel Options dialog to change it:

```
Sub DisplayZeros()  
    ActiveWindow.DisplayZeros  
= Not (ActiveWindow.  
DisplayZeros)  
End Sub
```

TOGGLE OTHER ON/OFF STATES

Some properties aren't set using True and False, so they're a little more challenging to create as a toggle macro. For example, you can set the direction in which Excel moves after you enter data in a cell using the 'MoveAfterReturnDirection' property

which takes the values of 'xlUp', 'xlDown', 'xlToRight' and 'xlToLeft'. If you only ever need to toggle between two states such as xlToRight and xlDown, here's how to do it using a Case...End Case statement:

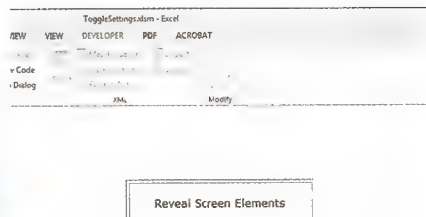
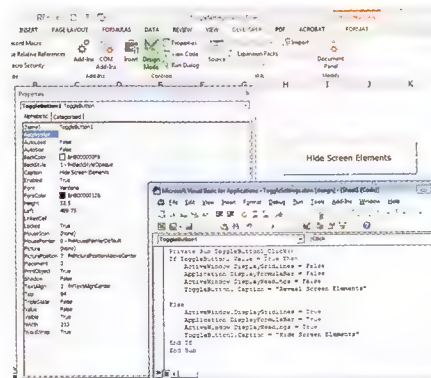
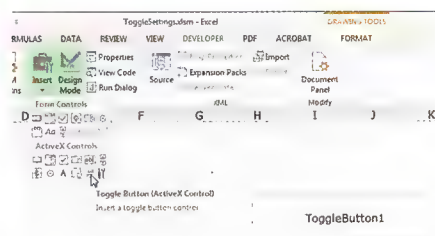
```
Sub ChangeDirection()  
    Application.MoveAfterReturn  
= True  
    Select Case Application.  
MoveAfterReturnDirection  
        Case xlDown  
            Application.  
MoveAfterReturnDirection =  
xlToRight  
        Case xlToRight  
            Application.  
MoveAfterReturnDirection =  
xlDown  
        Case Else  
            Application.  
MoveAfterReturnDirection =  
xlToRight  
    End Select  
End Sub
```

This macro starts by enabling the MoveAfterReturn property — if it is not enabled, the cursor is not advanced. It then checks the current setting and, if it is set to move Right, it changes this to move Down and vice versa. If the current setting is neither of these, then the macro sets the direction to Right.

USING THE TOGGLE BUTTON CONTROL

You can use the Excel ToggleButton control to change states. It has two settings — pushed in and raised. When raised, its value is set to True and, when pressed, its value is set to False. You can use this control to manage multiple settings at once. This code reveals or hides a number of screen elements on a press of the toggle button control. It also changes the button text so it's clear what it does:

```
Private Sub ToggleButton1_  
Click()  
    If ToggleButton1.Value = True  
Then  
        ActiveWindow.  
DisplayGridlines = False  
        Application.  
DisplayFormulaBar = False  
        ActiveWindow.  
DisplayHeadings = False  
        ToggleButton1.Caption =  
"Reveal Screen Elements"  
    Else  
        ActiveWindow.  
DisplayGridlines = True  
        Application.  
DisplayFormulaBar = True  
        ActiveWindow.  
DisplayHeadings = True  
        ToggleButton1.Caption =  
"Hide Screen Elements"  
    End If  
End Sub
```



1 STEP 1 Select the Developer tab, click 'Design Mode' and, from the Insert list, choose the Toggle Button (ActiveX Control). Drag a toggle button onto your worksheet.

2 STEP 2 Right click the button, choose Properties and set the Caption property to the button text. Right click the button, choose 'View Code' and type your code. Click 'Design Mode' to return to working in Excel.

3 STEP 3 To test your button click it and notice its two states — pressed and raised — and the changes that occur with each state. ■

Shoot long exposures on iPhone

Unleash your creativity by making the most of night-time photography with Dave Stevenson.

In conventional cameras, the shutter is the bit that opens and closes to let light hit the sensor. The longer the shutter is open, the brighter and blurrier an image. In iOS's built-in Camera app, the device sets a shutter speed automatically. This works out great most of the time, but in challenging environments, such as at night, it can be a struggle to get the desired result.

Nowhere is this more true than when it comes to photographing light trails. Long exposures at night record moving light sources as beautiful light trails – but only if you're able to set your camera to shoot an exposure that lasts for a few seconds or longer. This is where Slow Shutter Cam (\$2.99) comes in. It allows you to set a shutter speed from a quarter of a second up to 60 seconds, and even allows you to set a 'bulb' exposure, where the sensor records for the whole duration that you press the shutter button.

In this tutorial, we concentrate on light trail images, but Slow Shutter Cam offers loads of options. For example, tap the menu icon (bottom right) and you can choose to save images as higher quality TIFF or PNG files. Or if you simply want to take steady images, the app's Low Light mode (cog icon bottom left) can help you out.

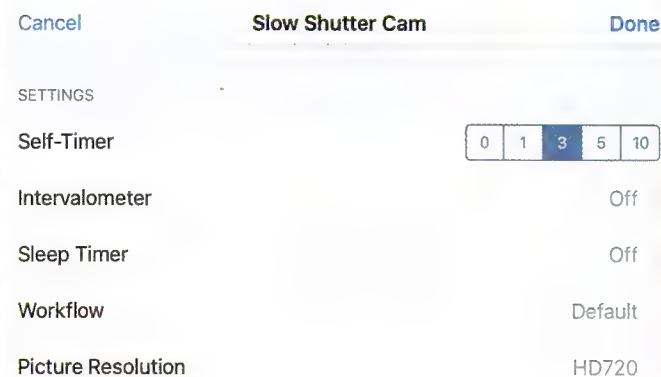
To take good long exposures, you're going to need a tripod. Of course, this means you'll also need to invest in a way to secure your iPhone or iPod touch to it. For this, we recommend the Glif tripod mount (US\$30, studioneat.com), the width of which can be adjusted to fit different sizes of iOS device.

Finally, you need to find a place with light trails to capture. Highways are the cliché we've opted for here, though there are plenty of other scenarios you can use to experiment: kids waving sparklers, fireworks displays and busy waterways at night are all options that should inspire you to get creative.

"To take good long exposures, you're going to need a tripod. Of course, this means you'll also need to invest in a way to secure your iPhone or iPod Touch to it."

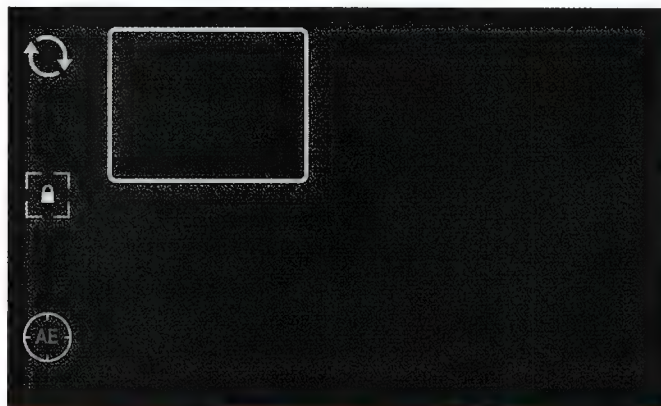
How to

Take long exposures with Slow Shutter Cam



1 GET SET UP

Once you've found the perfect place, set up your tripod and ensure it doesn't get buffeted around by the wind. In Slow Shutter Cam, tap the menu icon and set Self-Timer to three seconds to stop you nudging the camera when you take a pic.



2 FOCUS

Focusing in the dark is tricky, so your best bet is to tap the screen on the headlights of a passing car, then tap the AF icon — second from the top here — to lock the focus. This may take a bit of trial and error, but it's crucial to get it right.



3 FIRE AWAY

The centre button fires the camera after your preset interval. If you choose not to clear the image after the exposure is finished, subsequent ones are overlaid on top of it — useful if your first attempt doesn't give quite the finish you're after. ■

Control music with your Apple Watch

Craig Grannell shows how to turn your Apple Watch into a remote control and a standalone player.

A key reason to own an Apple Watch is to make it less necessary to fish your iPhone out of a pocket – or in some cases, to remove the need for an iPhone altogether. One area in which this works well is music, where Apple Watch can act as a remote to control playback on other devices, or as a standalone music player. In the former case, controlling playback using an Apple Watch is about convenience, yet having the wrist-based device as a player becomes a tempting proposition in situations when an iPhone could be unwieldy, such as when you're at the gym.

For remote control, you can use two of the built-in Apple Watch apps: Music and Remote. In the case of Music, by selecting your iPhone as the source, the app lets you browse music on your iPhone and pick something to play.

If you're in a hurry or indecisive, there are alternative means of getting to your music. You can call upon Siri to select a track, album, playlist or band. Alternatively, use the Music app's Beats 1 or Quick Play buttons to fire up Apple's internet radio station or play something random from Apple Music, respectively. Once something is playing, your Watch's Music glance gives you a quick way to skip tracks, pause and resume playback, adjust the volume level, and mark the currently playing track as a favourite.

Meanwhile, the Remote app provides the means to select a device on your network – a Mac or PC running iTunes, or an Apple TV – that has Home Sharing activated, and then skip tracks and change the volume.

LEAVE YOUR IPHONE BEHIND

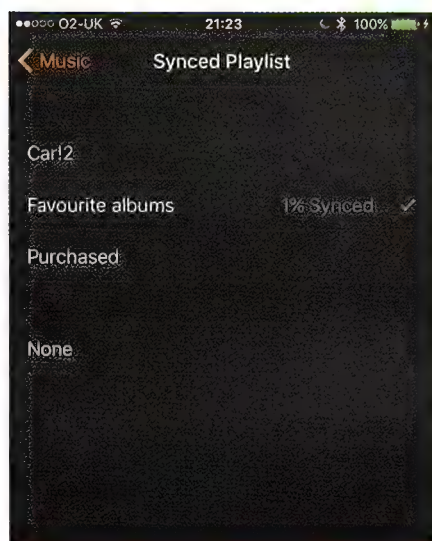
When it comes to using your Watch by

itself, you'll need to pair Bluetooth headphones first, to which the Watch subsequently streams playback. Once you've done that, you can sync music to your Apple Watch using the process outlined in the walkthrough.

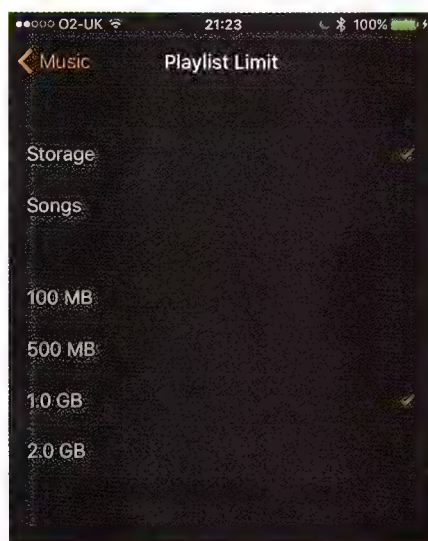
It's worth noting a couple of things when doing so. First, you can limit how many songs are synced to your Watch by total quantity instead of storage space if you want. Secondly, and more importantly, syncing songs over Bluetooth to your Watch is an extremely slow process. We recommend creating a playlist with a smallish number of songs that you want to copy across, geared towards whatever task you'll do with your Watch (such as uptempo numbers for gym sessions). Alternatively, prepare the sync before you go to bed and leave it running overnight.

How to

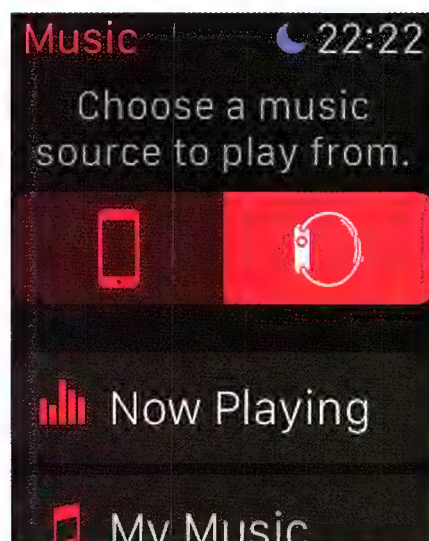
Sync music to your Apple Watch



1 SELECT A PLAYLIST
Open the Watch app on your iPhone, then scroll down to find Music and tap it. Tap 'Synced Playlist' and select the playlist you'd like to sync to your Apple Watch. If your Watch is charging, the sync process will start immediately.



2 ADJUST THE LIMITS
The Watch app defaults to syncing 1GB of music from your iPhone to your Watch (which has little storage), but you can increase this to 2GB, or reduce it as far as 100MB. Once the process is done, the number of synced songs is shown.



3 PLAY SOME MUSIC
On your Watch, open the Music app and select 'Apple Watch' as the source to play from. Use the My Music and Playlists options to browse the music you synced to your Watch, and to select and play it through paired Bluetooth headphones. ■

Encrypt email on Mac

Add extra layers of security and privacy to your Apple Mail email conversations with Nick Peers.

It's one of the internet's worst-kept secrets that email is an inherently insecure medium. Security and privacy weren't part of its original design, and no matter how careful you and your recipient are to ensure no one is peeking when you read messages, the fact is: it's still vulnerable.

One of the easiest ways in which email is hijacked is through email spoofing. It's very easy to fake an email address when sending a message, which is used to trick people into thinking a message is genuine when it's not. One way to counter this problem is to digitally sign your emails. If your recipients are forewarned – why not put a warning in your email signature? – they'll know to treat any unsigned emails purporting to be from you with a suitable level of suspicion.

It's possible to go further and digitally encrypt email using a signature, too – but this requires cooperation between you and each individual contact. Both you and your email partner require digital signatures configured to encrypt as well as digitally sign messages.

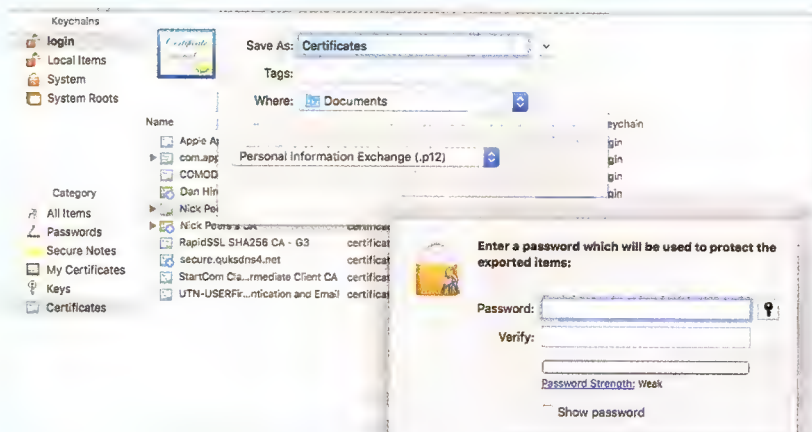
MAKE USE OF KEYCHAIN ACCESS

While it's possible to provide digital signatures through third parties, these either cost money or come with strings attached – typically a single year's use before the certificate expires. Luckily, the tools to create a signature that can identify you and encrypt mail are built in to OS X's Keychain Access utility.

The process involves setting up your own self-signed Certificate Authority (CA), which acts like a master certificate maker. Once created, you use this to generate a single certificate designed specifically for a single email

Expert tip!

It's possible to export your certificates for use in other email clients such as Thunderbird too. Consult the app's help file for info.



address. If you have multiple email addresses, you can set up separate certificates for each of them. The walkthrough opposite details the process you need to follow.

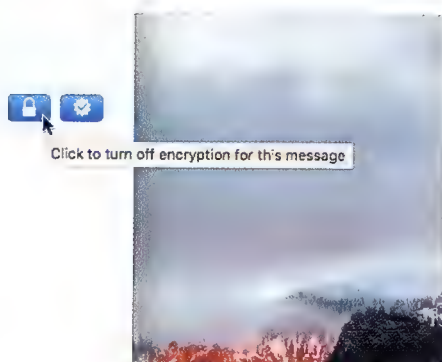
USE YOUR CERTIFICATES

The first time you open Mail and compose a new message from the email address you've digitally signed, you'll see a blue check mark alongside a dimmed padlock. The first task is to send an email to your recipient informing them you've set up a digital signature.

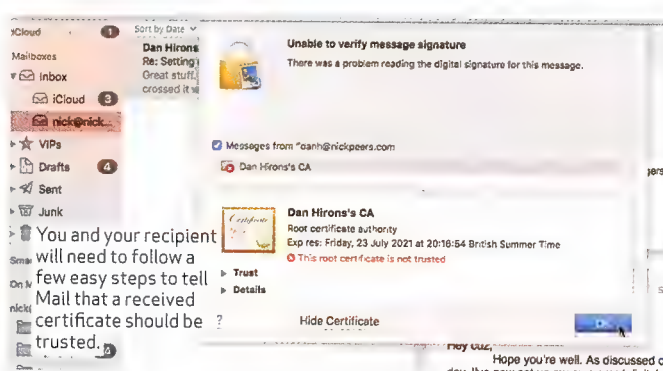
As your certificate is a self-signed one, it requires manual verification by the recipient; this process varies from app to app, but in the case of fellow Mail users, they'll need to click the

Show Details button next to the warning, then Show Certificate. At this point, it's a case of putting a check mark next to 'Messages from <email> are valid if signed by <certificate name>' and clicking 'OK'. This places your certificate in their keychain – open Keychain Access to review it – and future signed messages from you are marked as such.

If they then reply to the message with their own signed certificate, and you verify it, future messages between the two of you should see the padlock become available – just click this to lock it and future conversations will be encrypted and private. Also keep an eye out for incoming messages, which should also clearly be labelled as signed and/or encrypted when appropriate.

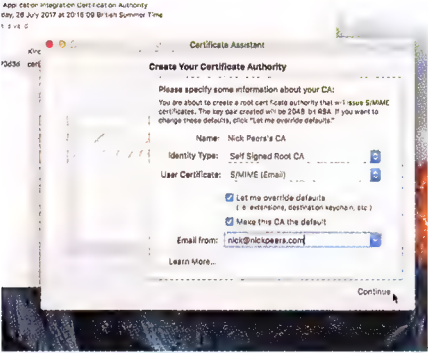


After exchanging certificates, messages can be encrypted.

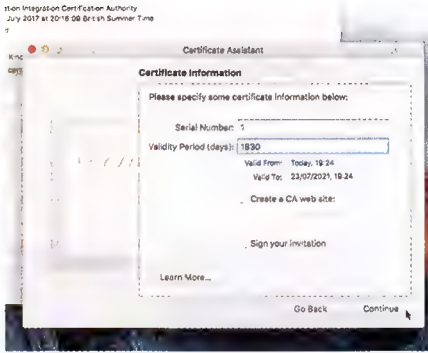


How to

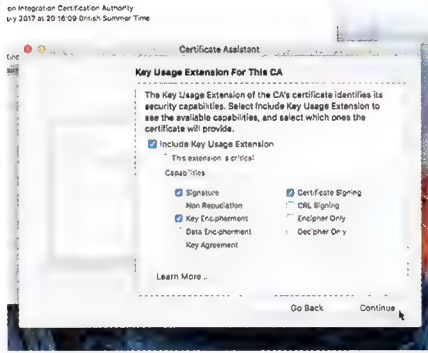
Set up your certificate



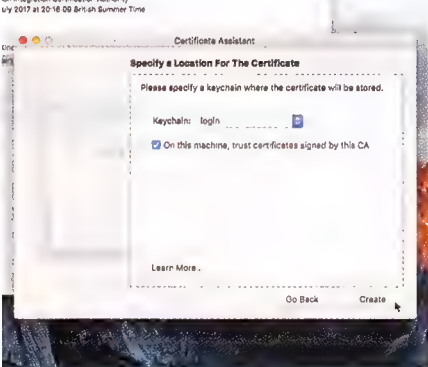
1 CREATE AN AUTHORITY
Open Keychain Access (it shows up in Spotlight) and pick 'Keychain Access > Certificate Assistant > Create a Certificate Authority'. Put a check mark next to 'Let me override defaults', enter your address under 'Email from', then click 'Continue'.



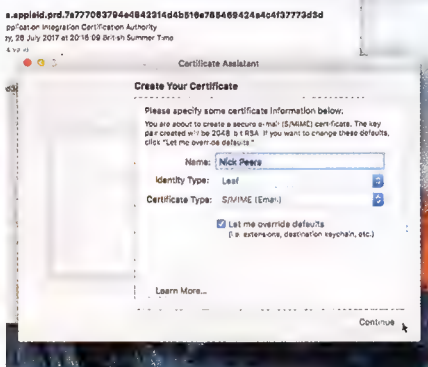
2 SET AN EXPIRY DATE
Your CA is set to expire after a year. Extend its life by entering a higher value next to 'Validity Period'. Clear the check mark next to 'Sign your invitation', click 'Continue' to enter some personal details, then click 'Continue' again.



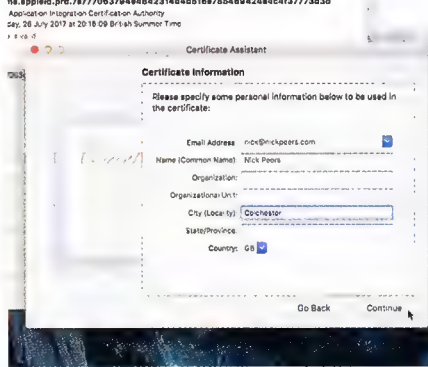
3 SET KEY USAGE INFO
The key pair info (2048 bits long and using the RSA algorithm) is fine as is, so click 'Continue' twice. At the Key Usage Extension page, put a check next to 'Key Encipherment', 'Certificate Signing' and 'Signature', then click 'Continue'.



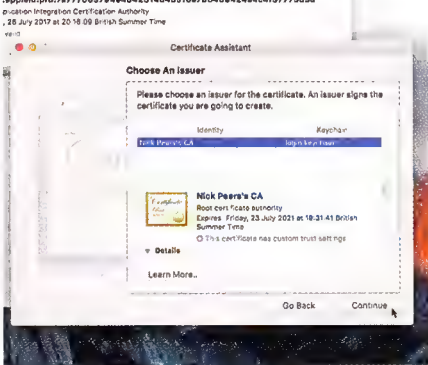
4 COMPLETE THE ASSISTANT
On the next page, put a check next to 'Key Encipherment' and 'Signature', then click 'Continue' until you reach the 'Specify a Location For The Certificate'. Enable 'On this machine, trust certificates signed by this CA', then click 'Create'.



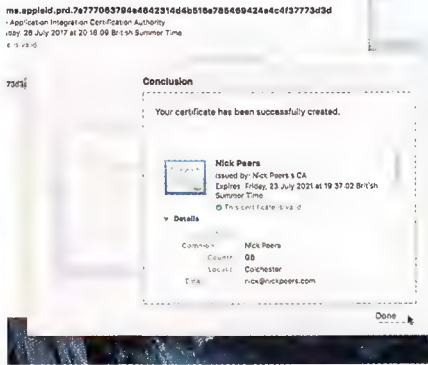
5 SET UP A CERTIFICATE
Close Certificate Assistant, then choose 'Keychain Access > Certificate Assistant > Create a Certificate'. Set Identity Type to 'Leaf', put a check mark next to 'Let me override defaults', and then click the 'Continue' button.



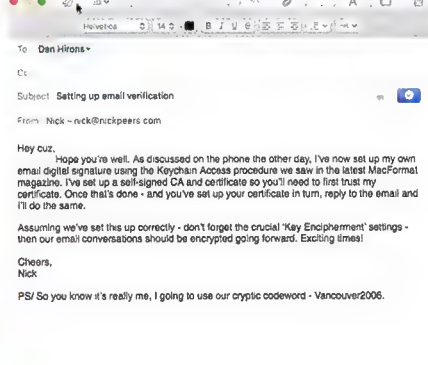
6 TWEAK SETTINGS
Specify how long you want your certificate to last before it expires, then click 'Continue'. Enter some personal details (an email address is mandatory, buying the rest is optional) and then click 'Continue' once again.



7 CHOOSE AN ISSUER
Make sure the Certificate Authority you created is selected (it'll probably be the only one listed), then click 'Continue'. Run through the rest of the assistant, ensuring you enable 'Key Encipherment' on the Key Usage Extension page.



8 COMPLETE THE ASSISTANT
Verify your email address is listed under 'rfc822Name' and finally click 'Create'. The certificate should be listed as valid, meaning it's ready to use. Click 'Done' to add it to your keychain, quit Keychain Access and open the Mail app.



9 SEND YOUR MESSAGE
Open a new message window and compose an email. You should see a blue button with a check mark in it next to the Subject field, which indicates the digital signature will be sent with your message to prove your identity to the recipient.

Use the Linux Terminal to change your display settings

Nick Peers goes beyond the confines of Screen Display settings to take full control of your display resolution settings with xrandr.

Xrandr is your best friend if you're looking for a way to manipulate your monitor's display through the Terminal. It's the command-line tool that gives you control over RandR ('Resize and Rotate'), the protocol used for controlling the X Window desktop. RandR can be configured through the Screen Display Settings tool, but it's limited in scope and, as you're about to discover, xrandr can do much more.

Let's dive straight in and see what xrandr can do. First, open the Terminal and type `# xrandr`. This will list the following attributes: **Screen 0**, a list of supported inputs from the computer (a combination of LVDS for laptop displays, DVI, VGA and HDMI ports) and finally a list of configured desktop resolutions.

Screen 0 is the virtual display — this is effectively made up of the outputs of all monitors attached to your PC (so don't think of them as separate entities, but components of this larger, virtual display). Its maximum size is enough to comfortably fit up to eight full HD screens at once, although in practical terms, you're likely to have no more than 1–3 displays attached. The current size displayed here is the sum of all your displays, and reflects whether they've been configured to sit side by side or on top of each other.

Next, you'll see that each supported display input is listed as disconnected or connected. Whichever input is connected will correspond to the display in question, either LVDS for

```
nick@nick-pc:~$ cvt 1920 1200 60
# 1920x1200 59.88 Hz (CVT 2.30MA) hsync: 74.56 kHz; pclk: 193.25 MHz
Modeline "1920x1200_60.00" 193.25 1920 2056 2256 2592 1200 1203 1209 1245 -hsync +vsync
nick@nick-pc:~$ xrandr --newmode "1920x1200_60.00" 193.25 1920 2056 2256 2592 1200 1203 1209 1
245 -hsync +vsync
nick@nick-pc:~$ xrandr --addmode HDMI-1 1920x1200_60.00
nick@nick-pc:~$ xrandr
Screen 0: minimum 320 x 200, current 2304 x 768, maximum 16384 x 16384
DVI-I-1 disconnected (normal left inverted right x axis y axis)
HDMI-1 connected primary 1280x720+0+0 (normal left inverted right x axis y axis) 477mm x 268mm
  1920x1080    60.00 +  50.00   59.94
  1920x1080i   60.00   50.00   59.94
  1680x1050    59.88
  1280x1024    75.02   60.02
  1440x900     59.98
  1280x960     60.00
  1280x720     60.00*  50.00   59.94
  1024x768     75.08   70.07   60.00
  832x624      74.55
  800x600      72.19   75.00   60.32   56.25
  720x576      50.00
  720x480      60.00   59.94
  640x480      75.00   72.81   66.67   60.00   59.94
  720x400      70.08
  1920x1200_60.00 59.88
VGA-1 connected 1024x768+1280+0 (normal left inverted right x axis y axis) 1024x768mm
  1024x768     60.00*
```

One of the main uses for xrandr is to open up Ubuntu to use all your display's supported resolutions.

a laptop's internal display, or DVI, HDMI or VGA for external monitor connections. Next to this is the current resolution, plus — if two or more display monitors are currently connected — their positions in relation to each other (for instance, '1920x1080+1920+0' indicates the display in question is to the right of the main one, while '1920x1080+0+1080' would place it beneath the primary display). You'll also see some additional information in brackets next to each input (such as, normal left inverted right x axis y axis). This refers to the way the screen has been rotated.

XRANDR SETTINGS

Beneath this, you'll then see a list of supported display resolutions, from the highest resolution to the smallest.

You'll also see a list of numbers to the right of these. Each number refers to a supported frame rate (typically between 50Hz and 75Hz), with the currently selected frequency and resolution marked with a '*' symbol. Framerates aren't important on LCDs in the way they are on older cathode-ray models — as a rule of thumb, the default setting (typically 60Hz) should be fine, but some displays do support up to 144Hz.

The main use for xrandr is to change the display resolution of your monitor, which is done with the following command:

```
# xrandr --output HDMI-0
--mode 1680x1050
```

Substitute 'HDMI-0' for the connected display, and '1680x1050' for the desired mode from those

Make xrandr changes persistent

If you want to make your edits permanent, you'll need to edit some config files. The standard way of doing this is using `xorg.conf`, but it can be quite fiddly. If you're looking for a fast and dirty way of changing screen resolution, and are happy to accept that it'll affect the screen only after you log on as your user account try: `# nano ~/.xprofile`.

Ignore the error, and this should generate an empty, hidden file called `xprofile`. Type your commands into the file as if you're entering them into the Terminal, one per line. The following example creates and applies a new resolution setting on boot:

```
xrandr --newmode "1368x768_60.00" 85.25
1368 1440 1576 1784 768 771 781 798#
xrandr --addmode HDMI-1 1368x768_60.00
xrandr --output HDMI-1 --mode
1368x768_60.00
```

Press Control-O to save the file, then Control-X to exit. The file needs to be executable, so use: `# sudo chmod +x ~/.xprofile`. Reboot your PC and you should find that it boots to the specified resolution.

Troubleshoot display issues

xrandr is a powerful tool, but as with all good command-line tools, things can go wrong. If your displays get messed up, then simply logging off and back on again should reset them to their defaults, or you can try `xrandr -s 0` to reset the main display to its default setting.

If you're unsure about whether or not a resolution will work correctly, try the following line when setting a new resolution:

```
$ xrandr --output HDMI-0 --mode 1920x1200_60.00 && sleep 10 && xrandr --output HDMI-0 --mode 1920x1080
```

supported. You can also set the frame rate by adding `--rate 60` to the end, but as we've said, this isn't normally necessary.

If you've got only one display attached, you can replace both `--output` and `--mode` flags with a single `'-s'` flag, which tells xrandr to set the resolution for the default display to the specified size

```
$ xrandr -s 1680x1050
```

ADD NEW RESOLUTIONS

Thanks to bugs in your hardware or drivers, the full set of resolutions your monitor supports aren't always detected. Thankfully, one of the big advantages of xrandr over the Screen Display utility is its ability to configure and set resolutions that are not automatically detected. The `cvt` command allows you to calculate the settings a particular resolution requires, then set up a new mode for xrandr to use before finally applying it to your target display. Start by using the `cvt` command like so:

```
$ cvt 1920 1080 60
```

The three figures refer to the horizontal and vertical sizes, plus the desired refresh rate (in most cases this should be 60). This will deliver an output including the all-important Modeline. Use the mouse cursor to select everything after Modeline, then right-click and choose 'Copy'. Next, type the following, adding a space after `--newmode` and without pressing Enter `$ xrandr --newmode`. Now right-click at the cursor point and choose 'Paste'. This should produce a line like the following:

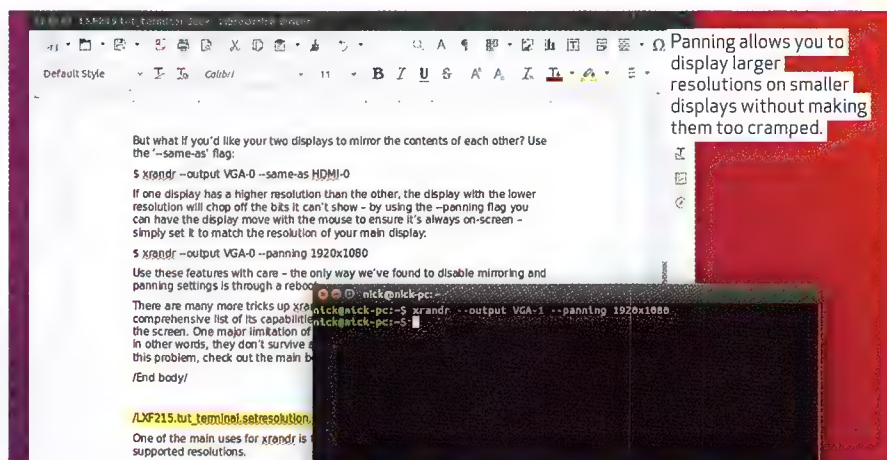
```
$ xrandr --newmode "1920x1200_60.00" 193.25 1920 2056 2256 2592 1200 1203 1209 1245 -hsync +vsync
```

Now hit Enter, then type `xrandr` and you should see that the mode has been added to the end of the list of supported resolutions. Should you wish to remove it at this point, use the `--rmmode` flag, for example: `xrandr --rmmode 1920x1200_60.00`.

Next, you need to add the mode to the list of supported resolutions. To do this,

This will attempt to set your new resolution, then after 10 seconds, revert to the original resolution. If the display goes blank this time, the new resolution isn't supported.

Sometimes, you may get a BadMatch error when attempting to add a resolution. This could be down to a number of issues. Try doing a web search for the error. We experienced a BadMatch (invalid parameters) error when attempting to add our own custom modes — this may have reflected the fact that one of our displays was connected through a KVM switch, but in the event, switching from the proprietary Nvidia driver back to the open-source Nouveau driver resolved the issue.



```
type: $ xrandr --addmode HDMI-0 1920x1200_60.00
```

Again, replace 'HDMI-0' with your chosen input, and make sure '1920x1200_60.00' matches exactly what was listed inside the quotation marks by the `cvt` command.

If the resolution is supported, you should now be able to switch to it:

```
$ xrandr --output HDMI-0 --mode 1920x1200_60.00
```

Should you subsequently want to remove this mode for any reason, first make sure you're not using it, then issue the following command:

```
$ xrandr --delmode 1920x1200_60.00
```

There are many more screen-related tricks up xrandr's sleeve. First, if you have multiple displays connected and you wish to quickly disable one, simply enter this line:

```
$ xrandr --output VGA-0 --off
```

If you want to bring it back, just replace `'-off'` with `'--auto'` for the default resolution, or `'--mode 1368x768'` for a specific supported resolution.

If you have two or more monitors set up, you may wish to change their positions within the virtual display. This is done by moving one display relative to the other using the following flags: `'--left-of'`, `'--right-of'`, `'--above'` and `'--below'`, for example:

```
$ xrandr --output VGA-0 --left-of HDMI-0
```

This would move the VGA-connected monitor's display to the left of the display connected via your HDMI port.

MIRROR DISPLAYS

But what if you'd like your two displays to mirror the contents of each other? For this, use the `'--same-as'` flag:

```
$ xrandr --output VGA-0 --same-as HDMI-0
```

If one display has a higher resolution than the other, the display with the lower resolution will chop off the bits it can't show; by using the `'--panning'` flag, you can have the display move with the mouse to ensure it's always onscreen — simply set it to match the resolution of your main display:

```
$ xrandr --output VGA-0 --panning 1920x1080
```

Use these features with care — the only way we've found to disable mirroring and panning settings is through a reboot.

Even this isn't all that xrandr can do — type: `man xrandr` for a comprehensive list of its capabilities, including how to rotate, invert and scale the screen. One major limitation of xrandr is that its changes aren't persistent — in other words, they don't survive when you reboot or when you log off. (To get around this problem, check out the 'Make xandr changes persistent' box back on page 96). ■

Build a 'lifecam' using a Raspberry Pi Zero

Les Pounder shows us how to use the new Raspberry Pi Zero v1.3 and official Pi Camera to create a device to instantly capture the moment.

The new Raspberry Pi camera and the latest version of the Pi Zero with camera interface offer a compact HD recording platform and, with it, we can easily build our own 'lifecam' that can be worn slug about our person while out and about – and that's precisely what we're going to build in this month's tutorial!

For this project, you will need a Raspberry Pi Zero 1.3, a Pi Camera, the latest release of Raspbian, one LED, one 220-ohm resistor (RED-RED-BROWN-GOLD) and one momentary switch/pushbutton. All of the code for this project can be downloaded from the official APC mag site at www.apcmag.com/magstuff.

With the Raspberry Pi turned off, we install the ribbon cable for our camera into the Raspberry Pi. For Pi Zero users, this is a new port on version 1.3 of the board and requires the purchase of an adaptor cable. For other users, please insert the camera ribbon cable into the Camera port. For every Raspberry Pi, ensure that you carefully pull the tabs to unlock the port. For Pi Zero users, ensure the metal tips of the cable are facing the Raspberry Pi board. For other Pi users, ensure that the metal tips are facing the Ethernet/USB ports. Press the tabs to gently hold on to the cable.

For your button, you can use any type of momentary switch; commonly, they are four-pin square buttons, but you can purchase others from retailers. We used a small-capped button and soldered wires to the GPIO pins. For the LED, we used a multicolour LED and soldered a 220-ohm resistor to the long leg, the anode. We then soldered wires to each leg to connect to the GPIO. To power the unit, we used a USB battery pack that we picked up from eBay.

SETTING UP THE CAMERA

When we first boot our Raspberry Pi, we will need to enable our camera. From the main menu, navigate to Preferences and then to the Raspberry Pi Configuration application. In the application, look for the Interfaces tab and click on it. In the Interfaces section, click to enable the camera. Now click 'OK' and reboot your

Raspberry Pi. Once your Raspberry Pi has rebooted, navigate to the main menu, go to Programming and then open Python 3. Once the editor has opened, click on 'File > New' to create a new blank file. Immediately save this blank document as 'lifecamera.py'.

We start the code for this project with a configuration step that forms part of making our Python code executable outside of the Python 3 editor. It instructs Raspbian to use the Python 3 environment installed as standard:

```
#!/usr/bin/env python3
```

Next, we import a series of modules that will enable our code to use extra functionality.

```
import picamera
from gpiozero import Button, LED
import time
import datetime
from signal import pause
```

Our first import is the `picamera` library, necessary to work with the camera. Our second import is two classes from the `gpiozero` module (a module that enables easy use of the General Purpose Input Output). The first class is `Button`, for our input device, and the second is `LED` for output device. Another required import is `time`, a module that we use to control the pace of our project. We use the `datetime` module to create a time stamp for our video filenames. Last, we import the `pause` function from the `signal` module.

Next, we include two variables which will contain the location of our button and LED.

```
button = Button(17)
led = LED(27)
```

We imported the `Button` class from GPIO Zero and so now we create a variable called `button` that will store the GPIO pin used for our button, in this case `17`. The `Button` class automatically pulls pin 17 to high, so it's active.

When we press the button, we momentarily pull pin 17 to Ground (GND) which is the other pin attached to our button. This change in state is what triggers our code to start. The `LED` variable records the GPIO pin used (`27`) for our multicolour LED.



We now create a function that's used to group code into one place that we can execute by calling its name. Our function is called `video`.

Note: Code inside of our function is shown indented, to identify that it's part of the function:

```
def video():
    print("RECORDING")
    led.on()
```

Our first line in the function prints to the Python shell that we are recording. This line is optional but it is a handy debug step. Our second line of code turns the LED on (`led.on()`) for the duration that our video records for. Still inside of our function, we now use `with` to reference the PiCamera module as `camera`:

```
with picamera.PiCamera()
as camera:
```

The code (below) is indented so that it's still inside the `with` statement:

```
    timestamp = str(datetime.
datetime.now())
    timestamp =
timestamp[0:19]
```

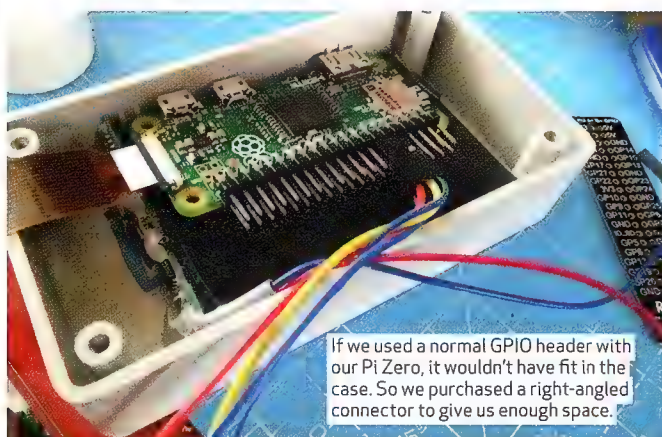
We create a variable called `timestamp` that will contain the current date and time, taken from the `datetime.datetime.now()`

Powering the project

For this project, we wanted to create a portable device that could be easily worn with little discomfort. So we elected to use the Raspberry Pi Zero with the new Pi camera. We enclosed the project in a project box, which can be bought from various electronics retailers.

But our biggest issue was powering the project. Yes, we could use a standard USB powerbank, but that would be too large. Luckily, we found a credit-card sized battery pack from eBay. This Lithium Polymer (LiPo) battery provides plenty of power and is relatively light, but we had to be careful as LiPo batteries are sensitive and can be dangerous if punctured or damaged. We carefully removed the battery and its protection driver board from the case.

We soldered wires from the output of the driver board to connect to the 5V and GND pins of our Pi. Powering the Pi directly from the GPIO. We knew that the LiPo was providing 5V and around 1 Amp and that was within the tolerances for the Pi. We protected the LiPo battery and driver board using hot glue and card to form a barrier between the Pi Zero and any loose components.



function. The `datetime` is also converted to a string using the `str()` helper function. On the following line, we update the contents of the `timestamp` variable by using string slicing to remove only the date time information that we require. Typically, this is from positions 0 to 19 (`00:19`) and contains the date and time in hours, minutes and seconds.

RECORDING FOOTAGE

We now set the resolution of our camera; in this case, we are recording at 1,280 x 720 pixels, commonly referred to as 720p. You can change the resolution up to 1080p or as low as 640 x 480 pixels:

```
camera.resolution = (1280, 720)
```

Next, we call the preview window to enable our test to see whether the camera is working correctly. This line can be removed from the final project, but it's handy to use for debugging purposes:

```
camera.start_preview()
    We now start the recording of
    our video:
    camera.start_recording(timestamp + ".h264")
    camera.wait_recording(30)
    We use the timestamp variable
    that we created earlier as the
    filename, and using concatenation,
    we join the ".h264" file extension
    to identify that it's a video. We then
    instruct the code to record for 30
    seconds to capture the action. We now
    stop the recording and stop the
    preview window. Remember that the
    preview window is an optional step
    and can be removed:
    camera.stop_recording()
    camera.stop_preview()
    With the video recording over, we
    now need to call the LED class and
    turn off the LED that we've attached
```

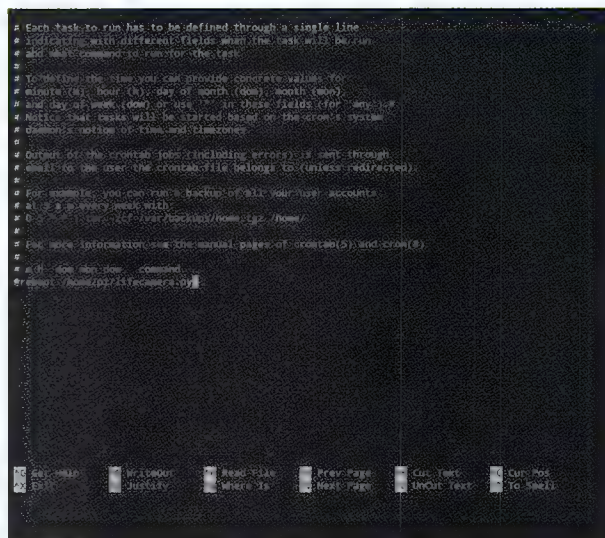
to pin 27 of the GPIO. This ends all of the codes for our `video` function.

```
led.off()

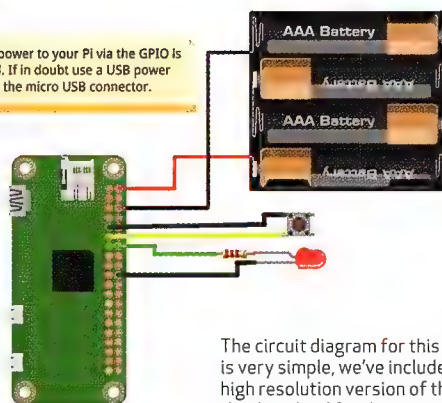
    We now move on to code that uses
    no loops, rather we use a function
    from the GPIO Zero Button class that
    will wait for the user to press the
    button on pin 17.
```

```
button.when_pressed = video
pause()
    When pressed, it will call our video
    function and run the code. The last line
    of code simply calls the pause
    function that will prevent our code
    from exiting.
```

With the code done, save your work and click on 'Run' 'Run Module' to test it. Remember to press the button to start the recording. To view your videos, power down the Pi, insert the micro SD card into a reader on your PC and use a viewer such as VLC. ■



Adding power to your Pi via the GPIO is optional. If in doubt use a USB power pack via the micro USB connector.



The circuit diagram for this project is very simple, we've included a high resolution version of this in the download for this project.

Code your own Android apps

Everyone is learning to code. But even if you don't know the right languages, there are multiple options for creating your own Android apps. Darren Yates investigates.

It seems as though almost everyone has been talking up learning to code in the last few months – from politicians to commentators and corporations large and small. As we speed head-on into the digital century, the need to train the next generation in computer science has taken on considerable urgency. Statistics vary but the European Commission expects a shortage of 825,000 ICT professionals in Europe by 2020 (tinyurl.com/j6vb7lk). Yet, as mobile devices take on a more central role in the global economy, demand for mobile app developers will also likely continue to rise.

Android has held over 80% of the world's mobile device market for much of the last three years, so if you're interested in coding mobile apps, on sheer numbers alone, Android isn't a bad place to start. But if you're not sure how to start, this month, we're looking at some of the options available – and those options are more diverse than you might realise.

NATIVE OR CROSS-PLATFORM

In general, there are two main ways of developing mobile apps – you can either search out a platform's designated or 'native' programming language and start coding with that, or you can aim to stick with a preferred coding language and look for cross-platform development tools that take your source code and convert or 'cross-compile' it into the platform's native language. Both native and cross-platform development methods have their advantages and drawbacks – which one you choose will often depend on which is cheaper and more efficient for your particular needs.

The native programming language for Android is Java and while 'going native' usually delivers the best app performance, it's by no means the only option. Even if you don't know a jot of Java, there are plenty of alternatives to get your ideas down in code.

With Android feasting on Java and Apple devices using the Objective-C language (or more accurately these days, Apple's comparatively-new Swift language), there's an obvious market for development tools that allow you to write just one source-code version to produce or 'compile' into apps that run

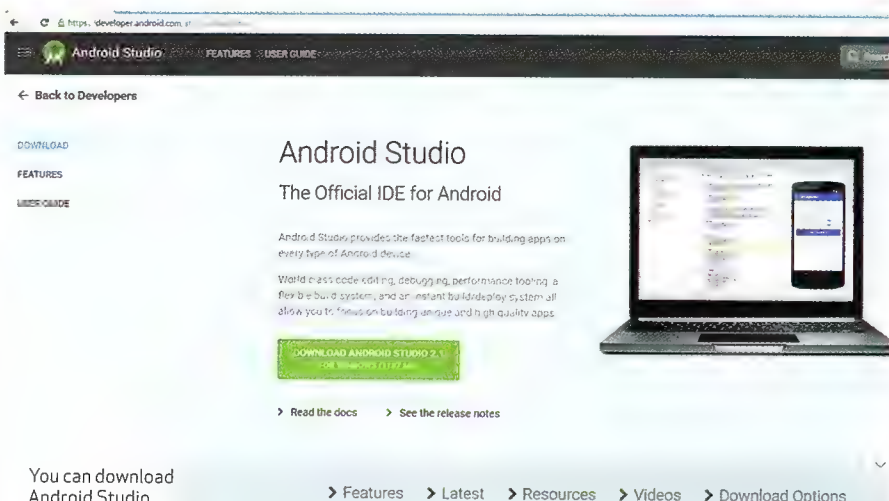
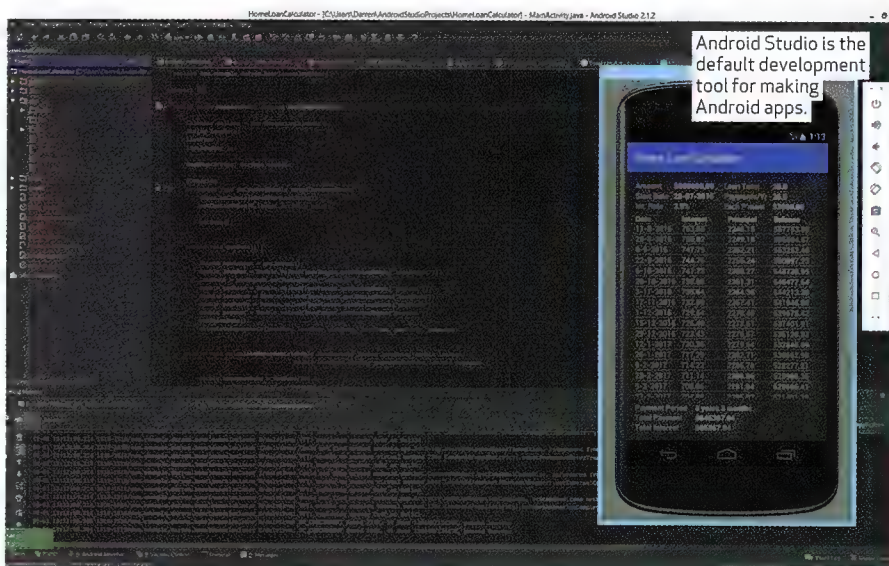
on both platforms. There's also a growing market for tools that enable developers to use languages other than Java or Objective-C for making mobile apps.

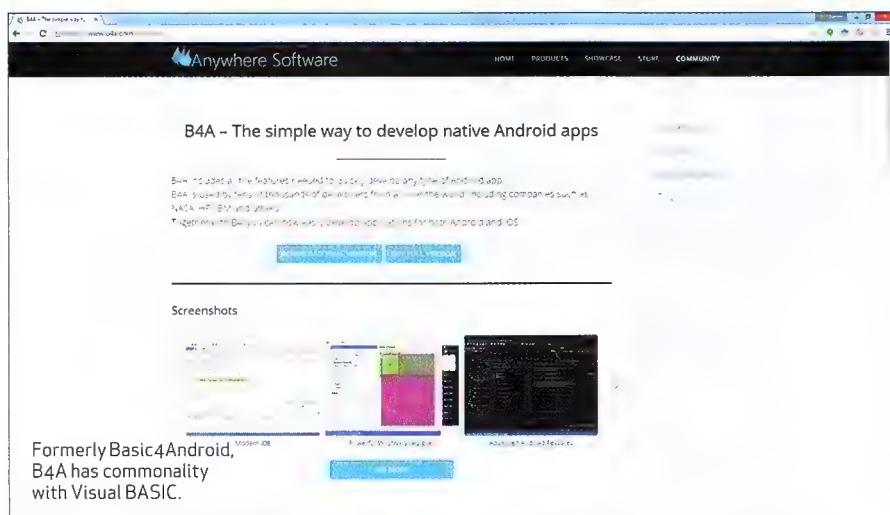
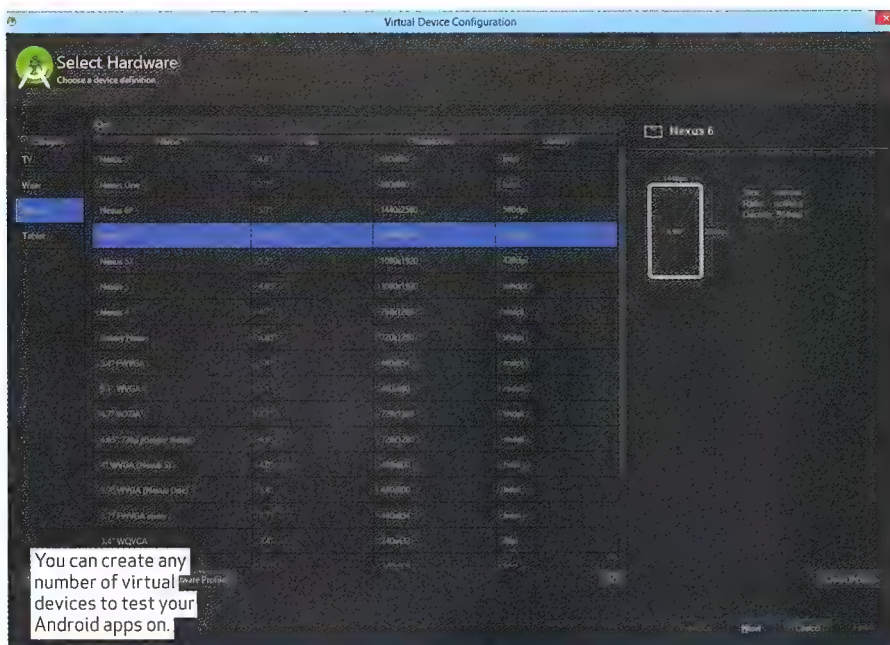
DRAWBACKS OF CROSS-PLATFORM

One of the most oft-quoted drawbacks of cross-platform development is the loss of access to native functionality. Think about learning another spoken language – common phrases or 'colloquialisms' in one language don't always transfer easily into the other. The same problem can arise in coding and has been a complaint about cross-

platform development in the past – while you can create neat code in one language and convert it into the native language you need with a suitable app, it's often difficult to get the same access to platform functionality as if using the device's native language.

However, improvements in many cross-platform development tools of late have toolmakers now claiming parity with native apps. But putting the arguments for and against aside for a moment, let's take a look at what's available.





"You don't need real Android hardware to test your code on — Android Studio can run your apps on virtual devices."

ANDROID STUDIO

If you know Java (and, hopefully, you've read my Java programming masterclass in APC over the last couple of years), Android Studio is your go-to platform. It's a modified integrated development environment (IDE) built on IntelliJ IDEA from software company JetBrains and is now the official development environment for Android. The good news is it's free to download and use, plus gives you all the tools you need to code and test not just smartphone and tablet apps, but also apps for Android Gear, Android TV and Android Auto.

You don't even need real Android hardware to test your code on — Android Studio can run your apps on virtual devices you create using the Android Virtual Device (AVD) manager (although real hardware testing should still be the goal at some point during development). The more recent version 2.x of Android Studio has received some major speed improvements and is much faster than the first release. If you're ready to give it a go, grab the latest version of the IDE from developer.android.com/studio/index.html. We recommend throwing a quad-core CPU at it, along with at least 8GB of

RAM to handle implementing the virtual Android devices. And as you need the SDKs for each version of Android you target, make sure you have sufficient storage to handle that, too (we recommend 20GB for safety).

The latest Android Studio 2.1 runs on any Windows system from 32-bit Windows 7 up, although I'd personally recommend at least 64-bit Windows 8.1 and a solid-state drive to speed up compilation and virtual device rendering — not to mention as much screen area as you can get (1,280 x 800 pixels minimum, 1,920 x 1,200 pixels or better is ideal).

If you're only interested in coding Android apps and you've got a decent handle on Java already, Android Studio is the obvious solution. It's a much better setup than the previous mash-up with the Eclipse IDE and makes app development more streamlined.

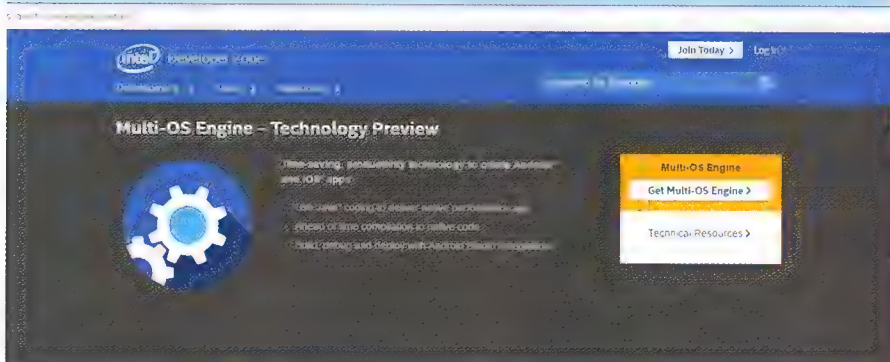
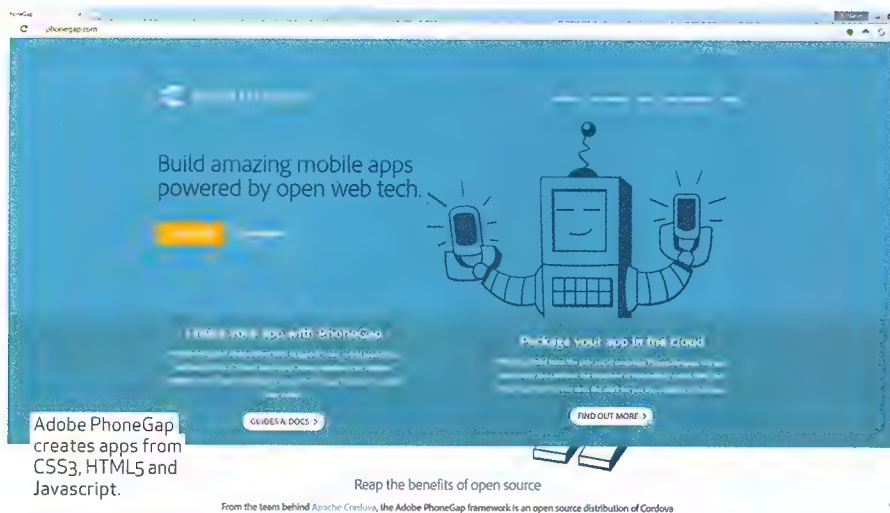
XAMARIN

However, if Java isn't your strongest suit, don't let that stop you. Microsoft's C# language isn't too dissimilar to Java and if you can code one, it usually doesn't take too long to pick up the other. But if you prefer C# (and it's a pretty damn good language to learn anyway), Xamarin is the tool you want. In fact, Xamarin is now even more desirable for C# coders, thanks to its purchase by Microsoft earlier this year. The Xamarin Studio Community IDE is now available free, but the SDK is also now bundled with Microsoft's Visual Studio 2015 development environment (including the free Community Edition), as well as available as an add-on for older Visual Studio 2013 editions.

Still, not everyone will be pleased with Microsoft's Xamarin purchase. One of the toys Xamarin itself bought in 2015 before being swallowed by Microsoft was a little tool called RoboVM, a Java-based cross-compiler that turned existing Java apps into Android and iOS apps. A few weeks after the Microsoft's purchase of Xamarin, RoboVM announced it was winding down. The most positive part of the announcement was the company stating that Android projects or apps developed in RoboVM Studio "can be opened and compiled in Android Studio or IntelliJ IDEA", along with pointing to tools that will import projects into Xamarin itself (tinyurl.com/hbfs2qq).

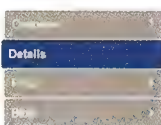
Xamarin comes with the boast that anything you can do in Java, Swift or Objective-C, you can do in C# with Xamarin, offering native access to platform APIs and performance.

Given Microsoft's decision to embed it into all versions of Visual Studio 2015, including the popular Community Edition, it now has the



use the time-saving and productive functions of Intel's Multi-OS Engine preview technology to utilize Java coding to create Android and iOS mobile apps.

The Multi-OS Engine is a standalone plug-in technology that integrates into Android Studio. Developers can turn a mobile app project as an Android project in Android Studio, then utilize the Multi-OS engine to configure the project to build and run as an iOS app on the iOS simulator. This simulator can be invoked from Android Studio. Knowledge of Objective-C is not needed to build your native app for iOS. Any native application logic that can be shared across these platforms, also can be reused.

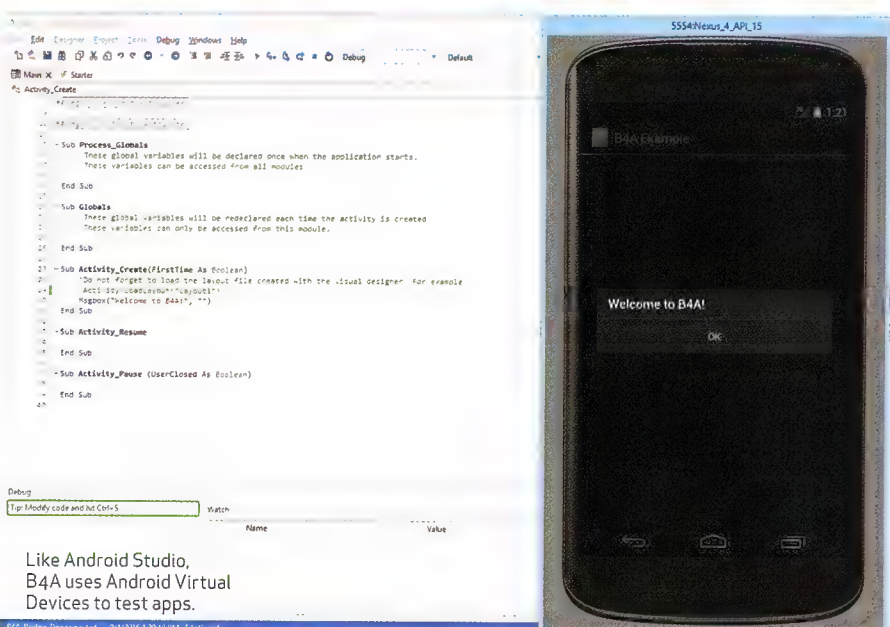


Documentation & Support

User Guide and Tutorials
Native API Reference
Webinars and Videos
Forum

Intel's Multi-OS Engine uses Java to code Android and iOS apps.

Create an App with Multi-OS Engine
Introduction to Cross Platform App Development



same licensing. The Community version is free for use by "individual developers, open-source projects, academic research, education and small professional teams", which Microsoft deems as five or fewer seats. You can grab hold of Visual Studio Community 2015 Edition free from Microsoft's website at tinyurl.com/kgjltwd. We'd recommend the same hardware minimums as for Android Studio.

INTEL TO THE RESCUE?

But if you still like the idea of cross-developing with Java, all mightn't be lost. Intel is better known as a maker

of processors and hardware in general, but is increasingly diversifying its portfolio of goodies and one of its latest toys is the new Multi-OS Engine, which launched as a first 'Technical Preview' just as this story was being written.

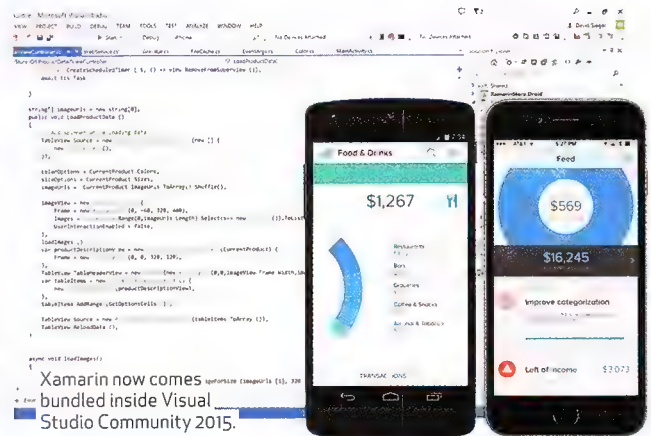
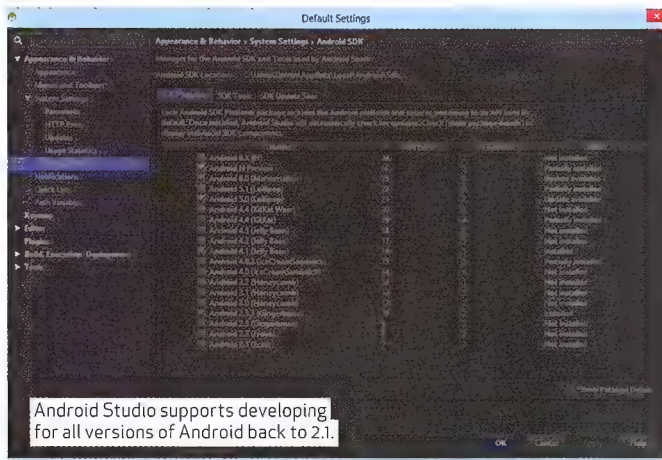
It's a standalone plug-in for Android Studio and, according to Intel, the way it works is that you start developing your Java code as normal, then use the Multi-OS Engine to configure and build your project as an iOS app. Even better, you don't need to know anything about Objective-C — Multi-OS Engine lets you use pre-built Java Archive (jar) files to connect with iOS' application programming interfaces (APIs). It also comes with tools for designing iOS-specific user interfaces for your apps.

If you think in Java, but still want the ability to code iOS apps without the hassle of learning Objective-C, Intel's Multi-OS Engine could well pick up where RoboVM left off. The licence for the Multi-OS Engine Technical Preview expires on the 31st of December 2016, so apart from not being production-ready, it's not clear what further changes will be made or how much it'll eventually cost. But in the meantime, it could be well worth having a play with anyway. You need to sign up with Intel to get access to the download, but you'll find it at software.intel.com/en-us/multi-os-engine.

PHONEGAP/CORDOVA

If your coding skills are more web-centric, you can still have a crack at developing Android apps via Adobe PhoneGap. Adobe bought PhoneGap developer, Nitobi, in 2011, releasing PhoneGap to the Apache Software Foundation to become Apache Cordova.

Adobe PhoneGap is the version you'll download if running a Windows system. It essentially allows you to create mobile apps



using CSS3 and HTML5 for the user interface and Javascript for the program logic. The trick is that PhoneGap then takes your essentially 'webpage' code, encases it in a WebView component and turns the whole thing into a compiled app, using cloud-based compilation services. It's a clever idea allowing you to create one source code that's compatible for any platform Cordova supports. You also still end up with a technically 'native' standalone app that can be installed on a mobile device (and uploaded to the app store), rather than a strictly 'web app' that relies on a server connection to deliver the brain-work.

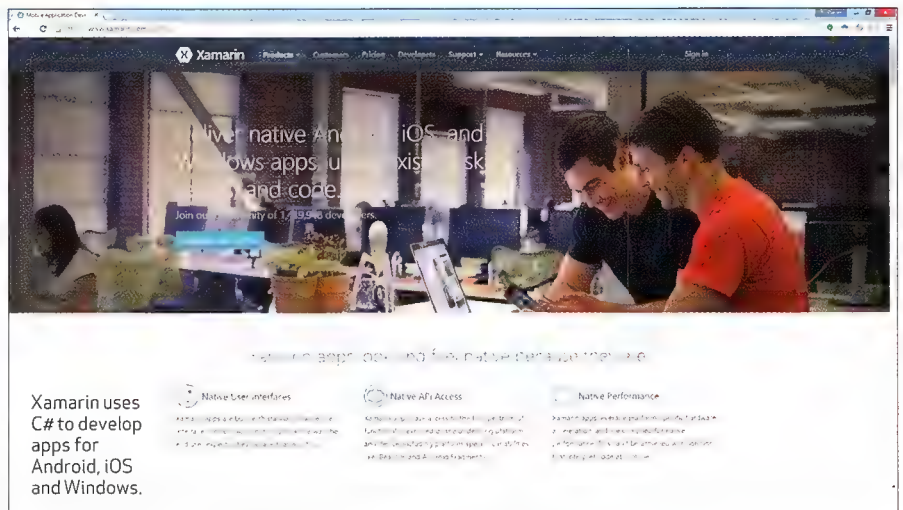
General consensus seems to be that this 'hybrid' form of mobile app is still likely slower than native development and it wouldn't be the choice for serious games development (that's where you definitely go 'native' all the way).

But for simpler apps where broad accessibility is important, where you don't have the coding chops to go with Xamarin or Android Studio and you don't want to deal with a server back-end, PhoneGap could be a happy middle-ground. Just make sure it's suitable for your application before you dive in too deep.

For example, you'll likely have to deal with at least one issue that plagues most web-based app development and that's the 300-millisecond delay when you tap on the device screen. All web browsers have it and it's because they have to also expect a double-tap for zooming (for instance, on maps). PhoneGap's documentation provides different solutions for this depending on your platform requirements, but it's something you need to consider. Grab PhoneGap from phonegap.com.

B4A

For better or worse, many of us learned how to code using some version of BASIC (Beginner's All-purpose Symbolic Instruction Code). It's funny, but many geeks get as fired up about various programming languages as



others do about their cars or football teams – and BASIC seems to be the language many geeks love to hate. The hate is directed at everything from BASIC's supposed reliance on GOTO statements and line numbers, to its lack of object support, its wordy syntax. But that's a very 1980s view. Many of today's BASIC dialects are strong on object-oriented programming (OOP), techniques now in vogue with most popular languages – and the days of line numbers are long gone. If nothing else, BASIC now seems essentially a collective term thrown over a diverse array of programming languages, from DOS's GW-BASIC to Visual BASIC to lesser-known but highly versatile RAD (rapid application development) platforms such as Xojo (xojo.com).

Anywhere Software has been around for a while now, producing a popular development package called B4A. Originally known as 'BASIC4Android', B4A no longer trades on its BASIC roots, but the language is still similar to Visual BASIC and churns out native Android apps. It also follows the Android Studio ability of tying in with Google's Android Virtual Device (AVD) manager to provide app testing on a virtual Android device before running

on real hardware.

B4A is just one of the company's offerings today and boasts NASA, IBM, HP, Honda, Bosch and Adobe amongst its users. Personally, I prefer native development through Android Studio, but if you're more comfortable with BASIC, the US\$59 investment in B4A could be well worth it. Head over to b4x.com to download a free 30-day trial and give it a go.

NATIVE IS BEST, BUT...

When it comes to building apps, the best option, technically, will always be to use a platform's native language. But if you're aiming to develop for the widest audience possible, cross-platform development done well can give you that coverage. It's also very likely to be the cheaper option since you're investing in one source code, rather than two or more.

But regardless, whether you code Java, C#, web-based languages such as HTML5 and Javascript, or even Visual BASIC, there are plenty of development tools available to get you coding your own Android apps. The only thing now stopping you is you. ■

Make your own digital compass

Turn an Arduino Nano into a simple digital compass using a low-cost magnetometer from Honeywell. Darren Yates explains how to build it.

I've been experimenting with the Arduino Nano microcontroller on a tiny 170-tiepoint breadboard over the last couple of months and, for this month's tutorial, I've put together a simple digital compass, incorporating the popular (and cheap) HMC5883L magnetometer and a tiny 128 x 64-pixel OLED display panel.

BUILDING IT

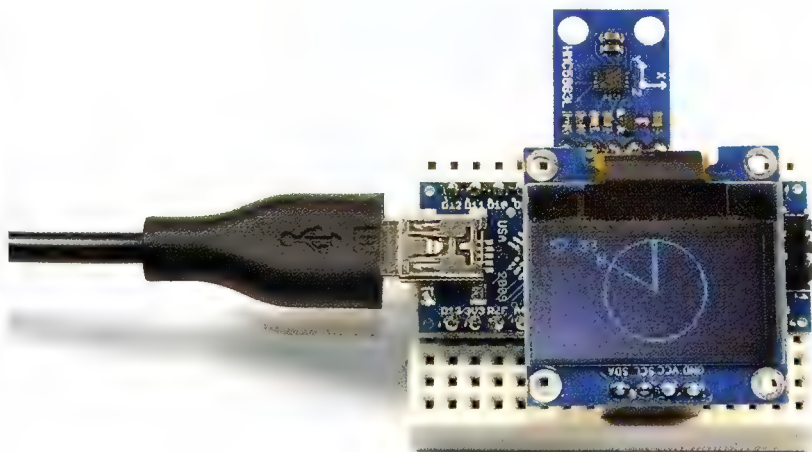
This digital compass has only four components – the Arduino nano microcontroller board, the 170-point breadboard, the HMC5883L module and a couple of wire links. Power is supplied via the Nano's USB port and the whole thing consumes around 60mA of current. You'll find all of the components available on eBay.

GET THE SOURCE CODE

Grab the source code for this project from apcmag.com/magstuff. Download it, unzip it, copy the contents of the 'libraries' subfolder into the same of your Arduino IDE (arduino.cc/downloads, get v1.6.9). Load the digicompass.ino source code into the IDE, plug in your Arduino nano board, flash the source code, plug it into your project, power it up and away you go. Use the overlay diagram and photos to see how we built ours.

INTER-INTEGRATED CIRCUIT

One of the data bus standards supported by the Arduino's ATMEGA328P chip is I2C or 'inter-integrated circuit'. It's a two-wire protocol, one wire for base clock (SCL) and one for data (SDA), and is popular with many low-power low-speed sensors and devices. The problem is, the ATMEGA328P only has one I2C bus, on pins A4 and A5. But in order to use both the 128 x 64-pixel OLED panel and the HMC5883L magnetometer module the way we want, we need two. I2C is an addressable bus system, meaning it can drive multiple dependent or 'slave' devices at once, each having a different pre-programmed address like houses on your street. However, we want the HMC5883L module on the other side of the breadboard where there is no I2C bus available. The solution is to use the excellent SoftI2CMaster code library,



Combine an Arduino Nano and magnetometer to create a digital compass.

which turns any two digital I/O pins into a software-powered I2C bus.

We've kept the hardware I2C bus for the OLED panel, as before, bringing in the soft I2C port for the HMC5883L module. We've also turned two digital I/O pins, D3 and D4, into power supply pins, allowing us to just plug the module straight into the breadboard without any jumper wires. The HMC5883L has a power consumption of around 100 microamps, which the I/O pins can easily supply. The OLED panel also needs DC power, however, because the appropriate Arduino pins, A6 and A7, are inputs only, we have to wire in power rails via wire links.

SOFT I2C

As for code, Soft I2C works almost the same as the genuine I2C bus, although there are some important differences. The main one is addressing. The I2C bus standard allows two addressing systems – 7-bit and 8-bit. While the default Wire library uses the 7-bit system, SoftI2CMaster requires 8-bit addresses.

You can try searching online for these addresses, but to be frank, I wouldn't trust anything I found that way. The most reliable method is to read the datasheet. Every integrated circuit device has a datasheet, which tells you

3-Axis Digital Compass IC HMC5883L

Honeywell

Advanced Information

The Honeywell HMC5883L is a surface-mount, multi-chip module designed for low-field magnetic sensing with a digital interface for applications such as low-cost compassing and instrumentation. The HMC5883L includes our state-of-the-art, high-resolution HMC1180 series magnetoresistive sensors plus an ADC, on-chip amplifiers, automatic degaussing, sleep drivers, offset cancellation, and a 12-bit ADC that enables 1° to 2° compass heading accuracy. The I²C serial bus allows for easy interface. The HMC5883L is a 3.3V 0.9mm surface-mount 16-pin leadless chip carrier (LCC). Applications for the HMC5883L include Mobile Phones, Handbooks, Consumer Electronics, Auto Navigation Systems, and Personal Navigation Devices.



The HMC5883L utilizes Honeywell's Anisotropic Magnetoresistive (AMR) technology that provides advantages over other magnetic sensor technologies. These anisotropic, directional sensors feature precision in-axis sensitivity and linearity. These sensors' 256-state construction with very low cross-axis sensitivity is designed to measure both the direction and the magnitude of Earth's magnetic field, from milli-gauss to 8 gauss. Honeywell's Magnetic Sensors are among the most sensitive and reliable low-field sensors in the industry.

FEATURES

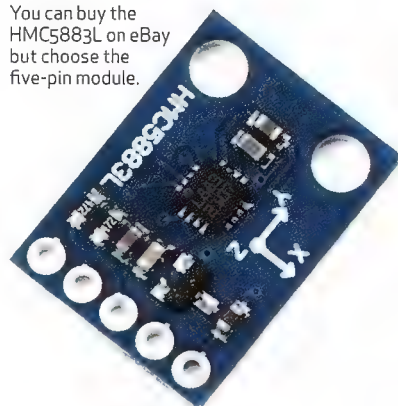
- 3-Axis Magnetoresistive Sensors and ADC in a 3.3V 0.9mm LCC Surface Mount Package
- 12-Bit ADC
- 1.2V to 1.0V
- 100µA
- Self-Test and Offset Compensation

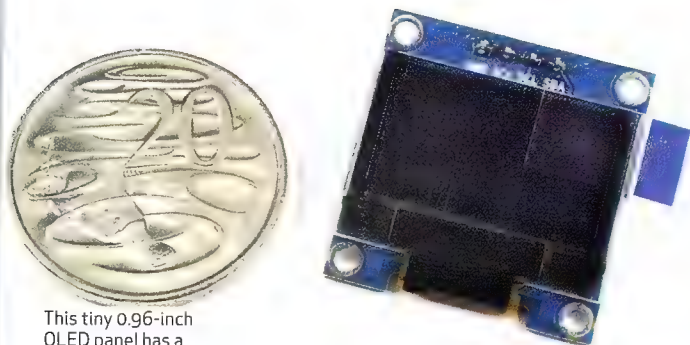
BENEFITS

- Small Size for Highly Integrated Products. Just Add a Micro-Controller Interface. Plus Two External SMT Capacitors Designed for High Voltage. Cost-Reduced SMT Design. Easy to Assemble & Compatible with High-Speed SMT Assembly.
- Significant Compass Heading Accuracy
- Low Power Consumption
- Low Cost
- Low Power Consumption

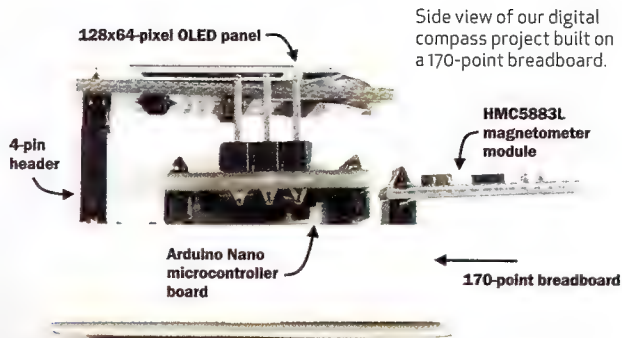
The HMC5883L datasheet tells you everything you need to know.

You can buy the HMC5883L on eBay but choose the five-pin module.





This tiny 0.96-inch OLED panel has a 128 x 64-pixel resolution.



Side view of our digital compass project built on a 170-point breadboard.

everything about the device. You can find the datasheet on the HMC5883L at tinyurl.com/apc433hmc (PDF). Learning to read datasheets is a fundamental part of becoming an electrical engineer – it's also a great way of avoiding dud advice from some websites – don't get me started! Seriously, it might seem geeky to go around reading datasheets, but there's no better way to learn how to use a device properly.

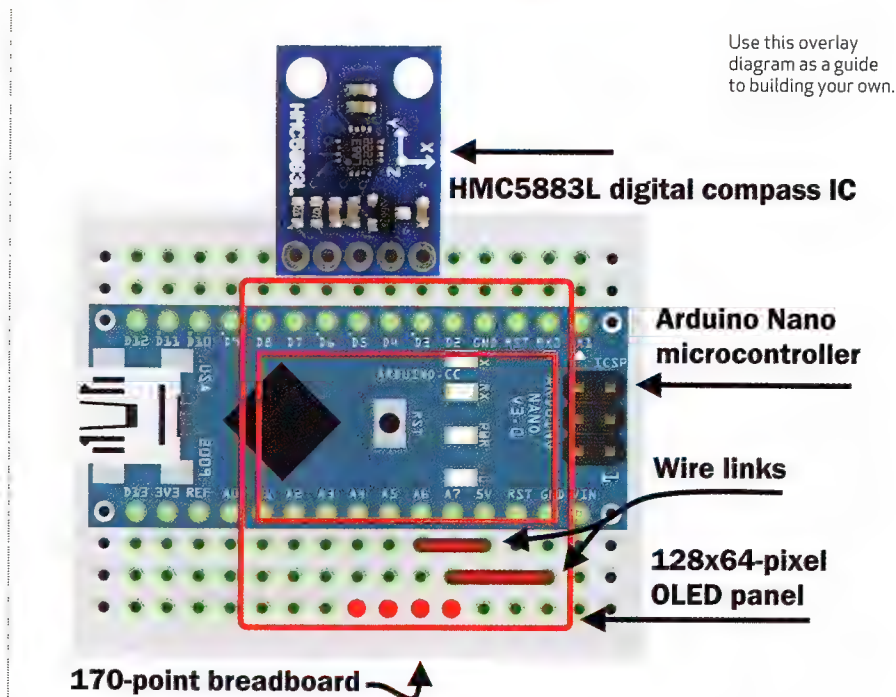
Meanwhile, the HMC5883L chip has two addresses in 8-bit mode, 0x3C for writing data to the device and 0x3D for reading data back again. (0x3D is hexadecimal code for the 8-bit address 00111101 – 0011 is '3' and 1101 is 'D'). If you were to use the HMC5883L on the standard hardware I2C bus with the default Wire library, the 7-bit address is 0x1E.

SETTING UP THE HMC5883L

The HMC5883L magnetometer measures low-level magnetic fields, including the Earth's, returning gauss values in the three axes: X, Y and Z. But to get the chip to start sending data, first we need to write to the device (address 0x3C) the value '0x02'. This is the 'mode register' (p. 11) and by next writing the value '0x00' (zero), we're telling the chip we want to retrieve data in continuous mode. This is done in our source code's 'setup()' method.

In the main 'loop()' method, we write again to the device (0x3C) that we now want to access the first of the data read registers – register 3 – and send the value '0x03'. To now read the data in all three axes, we contact the read address (0x3D) and initiate a byte-size read transfer through the 'i2c_read' command. Each axis value from the chip is a 16-bit number, so we read one byte, then the next, bit-manipulate to get the right result and repeat the process for all three integer variables – 'val_x', 'val_y' and 'val_z'.

We only need the X- and Y-axis values, along with the Arduino's



Use this overlay diagram as a guide to building your own.

Digital Compass - Overlay Diagram

ATAN2 (arctangent) function, to create a compass heading based on the raw magnetometer values. However, ATAN2 only returns the heading in radians, so we need a little more 'mathemagic' to get it into degrees. If you remember back-to-school maths, the sine and cosine functions can turn the heading back into X, Y coordinates we can then use on our OLED panel to draw a line representing the north heading.

READING THE COMPASS

The heading value appearing in the top-left of the display is your heading relative to north, also indicated by the two fixed guidelines on the compass circle. So if north is directly to your right, your heading is 270-degrees; if it's to your left, your heading is 90-degrees and so on.

SENSITIVITY

But our compass is by no means perfect. In fact, this project shows just how sensitive magnetometers can be. Bring a steel ruler or nail near the HMC5883L board – but not touching it – and you'll see the reading go berserk. But as a bonus, you could probably turn this into a metal stud finder with only a little work (metal detector apps on smartphones use the same trick).

Now to be honest, I wouldn't want to rely on this project as it currently is if I was lost in the bush, but it should still help give you a basic understanding of what a magnetometer is and how it works. ■

Learn to code Python — Part 2: branching out

In this second part of our new series on learning to code Python, Darren Yates begins looking at how to incorporate decision structures into your code.

In our introduction last month, we looked at the very basics of coding, learning to write simple programs that took input from the user, stored the data in a variable, processed the data, then output the result back to the user. It's a coding technique as old as the hills called 'input, process, output' or IPO.

However, the problem with those simple programs is that they can't cope with any deviation – it's like driving down a freeway and not being able to get off it. They start at the top, continue right to the bottom and that's it. So, this month, we're looking at ways of getting off the freeway, of being able to vary the execution order of your code, using 'decision structures'.

MAKING TEA

Most of us have a morning obsession – for many, its coffee; for me, its tea. Everything to me just goes better with a good cuppa. Anyway, here's a question – how would you code the process of making a cup of coffee? Well, let's start by using a simple technique called 'pseudocode', code written in plain English that explains line-by-line what you want your eventual 'real' code to do. To make a cup of coffee, it'd be something like:

```
Boil jug
Add four spoons of
'International Roast' to cup
Pour boiling water into cup
Stir cup
Drink coffee
```

Seems simple enough – except, what if there's no water in the jug? Boiling the empty jug will either blow up the element or it just won't boil, thanks to the jug's boil-dry sensor preventing it from switching on. So we need to first check the jug to see if it has water and

if not, to fill it up. In our pseudocode, we'd write something like:

```
If jug is empty, fill jug
Boil jug
Add four spoons... etc.
```

What happens now is that the jug is checked for water and if the jug is empty, the command 'fill jug' is carried out. If the jug isn't empty, the 'fill jug' part of the statement is ignored and we go straight to 'boil jug'. The 'if'-statement is the simplest form of what's called a 'decision structure' and it allows us to vary or 'branch' the code execution based on the input that arrives. It's simple, but it's arguably the most important concept in programming, for without it, few worthwhile apps could exist.

BOOLEAN LOGIC

But if we're going to write this as actual Python code, there's a branch of

mathematics we need to look at called 'Boolean Logic'. Relax, it's not that hard and you probably learned it in school.

A 'Boolean expression' is one that involves comparing at least two entities, with the comparison evaluating to 'true' or 'false'. For example, the expression 'the Queensland NRL State of Origin team is greater than the NSW team' would evaluate to 'true'; 'Hawthorn AFL team is less than Collingwood' would evaluate to 'false'; and 'tea is greater than coffee' is always 'true' (direct flame mail to apcmag@future.com).

[Ed – Gee, thanks Darren...]

These terms – 'greater than' and 'less than' – are members of a set of functions called 'relational operators'. Together with entities or values, they form relational or Boolean expressions. Python has six relational operators that you can see in the diagram at the top of the next page.

```
Python 3.5.1 Shell
File Edit Shell Debug Options Window Help
Python 3.5.1 (v3.5.1:37a07cee5969, Dec 6 2015, 01:54:25) [MSC v.1900 64 bit (AMD64)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: C:\Users\Darren\Python Code\Python_EP_2\tax.py =====
Please enter your salary in dollars: 65000
Tax on salary of 65000 is 12672.0
>>>
===== RESTART: C:\Users\Darren\Python Code\Python_EP_2\tax.py =====
Please enter your salary in dollars: 80000
Tax on salary of 80000 is 17547.0
>>>
===== RESTART: C:\Users\Darren\Python Code\Python_EP_2\tax.py =====
Please enter your salary in dollars: 125000
Tax on salary of 125000 is 34197.0
>>>
===== RESTART: C:\Users\Darren\Python Code\Python_EP_2\tax.py =====
Please enter your salary in dollars: 109454
Tax on salary of 109454 is 28444.98
>>>
```

```
Python 3.5.1 Shell
File Edit Shell Debug Options Window Help
Python 3.5.1 (v3.5.1:37a07cee5969, Dec 6 2015, 01:54:25) [MSC v.1900 64 bit (AMD64)] on win32
Type "copyright", "credits" or "license()" for more information.
>>> 5 > 2
True
>>> 2 > 5
False
>>> False
False
>>>
```

Boolean expressions using relation operators are either true or false.

```
five.py - C:\Users\Darren\Python Code\Python_EP_2\five.py (3.4.3)
File Edit Format Run Options Window Help
userNumber = int(input("type in a number between 0 and 9:"))
if (userNumber > 5):
    print("Your number, ", userNumber, ", is greater than 5")
if (userNumber == 5):
    print("Your number, ", userNumber, ", is equal to 5")
if (userNumber < 5):
    print("Your number, ", userNumber, ", is less than 5")
```

This simple code shows up if-statements can be used in your code.

if (condition_statement):

statement_if_1
statement_if_2
statement_if_3

executed if
condition
statement is
TRUE

else:

statement_else_1
statement_else_2
statement_else_3

executed if
condition
statement
is FALSE

The basics of how if-else
statement block works.



You have to check if
the jug has water
before you can boil it.

INTERACTIVE TESTING

Python doesn't natively understand 'Collingwood' or 'State of Origin' as concepts, but it does understand numbers, so let's try out some simple Boolean expressions in the Python interactive window and see what we get. Fire up the Python IDLE and type:

```
5 > 2
```

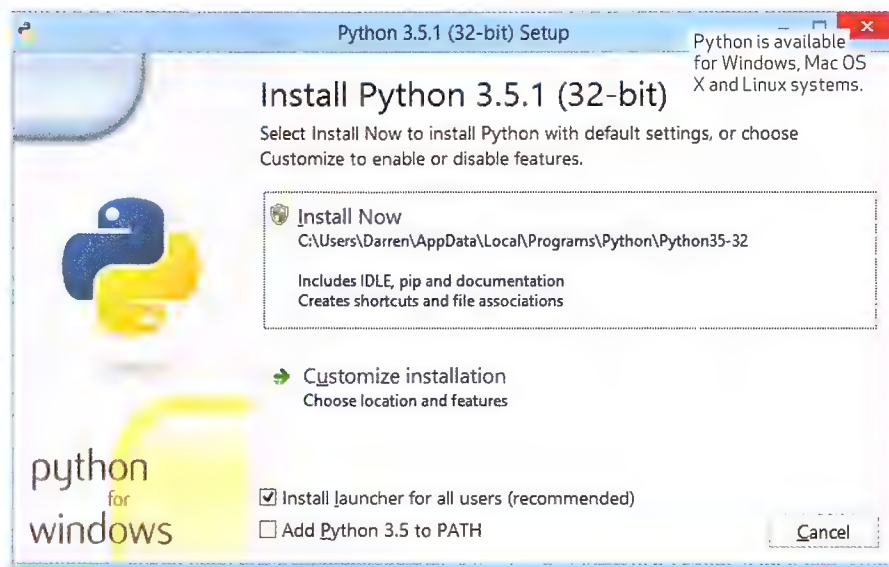
Press enter and hopefully, you get the response 'true', because five is greater than two. Let's try it the other way around:

```
2 > 5
```

Press enter. This time, the result should be 'false', because two is not greater than five. Now remember from last time, using actual numbers or 'literals' in code, while it works, it isn't terribly useful, unless you just want to evaluate whether or not five is greater than two all day long. But what you can also do is evaluate one variable against a constant or against another variable – that makes Boolean logic infinitely more useful.

Let's write some code:

```
userNumber = int(input("type  
in a number between 0 and 9:  
"))  
if (userNumber > 5):  
    print("Your number,"
```



```
userNumber, " is greater than  
5")  
if (userNumber == 5):  
    print("Your number,"  
userNumber, " is equal to 5")  
if (userNumber < 5):  
    print("Your number,"  
userNumber, " is less than  
5")
```

This simple app is called 'five.py' and you'll find it in this month's source code pack at apcmag.com/magstuff. The first line is similar to one we used last month – it displays the message 'type in a number between 0 and 9'; waits for the user to type in a response and press the Enter key, turns the string text typed into an integer and stores the result in a variable called 'userNumber'.

The next few lines all follow a similar pattern, but as they're new, we'll go over them slowly. First, we start with the command code 'if', indicating this is an 'if'-statement. Inside the brackets is a Boolean expression we want Python to evaluate for us, and after the closing bracket, it's finished off with a colon ':' character, which means there is extra code coming that relates to this statement. That extra code is the next line, but note that it's indented – this is a key formatting or 'syntax' structure that separates Python from most other programming languages. To indicate that a code line belongs to or is linked to one above, you must indent it by pressing the 'tab' key once.

The new indented line is a print statement, but it just prints 'your number is greater than 5'. Given that's all it prints, how do we know when it will print? It prints when the value of the variable 'userNumber' is greater than five (userNumber > 5). And this is the key point of if-statements – the code following an if-statement

expression executes only if that expression is true. So, if the value in userNumber is greater than five, the print line beneath executes; if it isn't, the print line is skipped.

If the print statement is skipped, it continues to the next codeline, which, in this case, is another if-statement, this time with the expression 'userNumber == 5'. Now this is a trick for new players – you must use double-equals characters '==' to indicate 'is equal to'. If a single equals character were allowed here, you'd be assigning the value '5' to the variable 'userNumber' – which isn't really what you want. However, in Python, do this and you'll get a syntax error when you try to run the code, so remember, its double-equals (==).

IF-ELSE STATEMENTS

We now know if-statements allow you to execute code when its Boolean expression evaluates to true, but what about running code that alternatively evaluates to false? That's where the 'if-else' statement comes in. Look at the simple 'pass/fail' code below:

```
score = int(input("Enter your  
test score out of 100: "))  
if (score >= 50):  
    print("Awesome! You  
passed!")  
else:  
    print("Bad luck - you  
failed.")
```

You'll find this as 'score.py' in the source code pack. First, we ask the user to enter in their test score. Now with most tests, score 50 or more and you pass; less than 50 and you fail. The if-statement checks to see if the user's test score (stored in the variable 'score') is greater than or equal to 50. If it is – meaning the Boolean expression evaluates to true – it prints the happy

message. Now note the 'else' statement – this marks what happens when the expression is false, meaning, in this case, that the score is less than 50 (if a score is not greater than or equal to 50, it must be less than 50). In this case, we print out the 'bad luck' message.

What's great about this is that we can direct which codelines execute based on the input from the user using simple relational operators and Boolean expressions.

CALCULATING INCOME TAX

Finally, this month, we're going to pull it all together with something moderately useful – working out your income tax. Search 'australia income tax rates' and you'll get the income tax tables for the 2016/17 financial year from the Australian Tax Office, namely:

```

$1 - $18,200
- Nil tax
$18,201 - $37,000 - 19cents
for each dollar over $18,200
$37,001 - $80,000 - $3,572
plus 32.5cents for each dollar
over $37,000
$80,001 - $180,000 - $17,547
plus 37cents for each dollar
over $80,000
$180,001 and up - $54,547
plus 45cents for each dollar
over $180,000
    
```

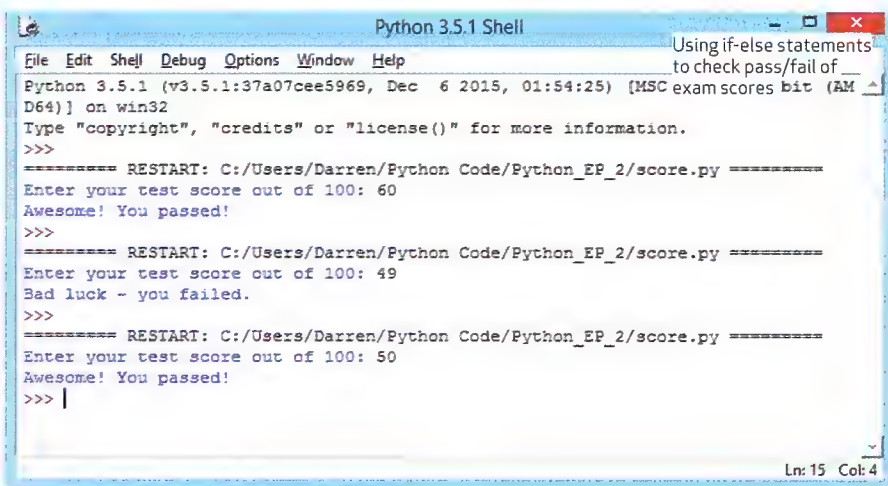
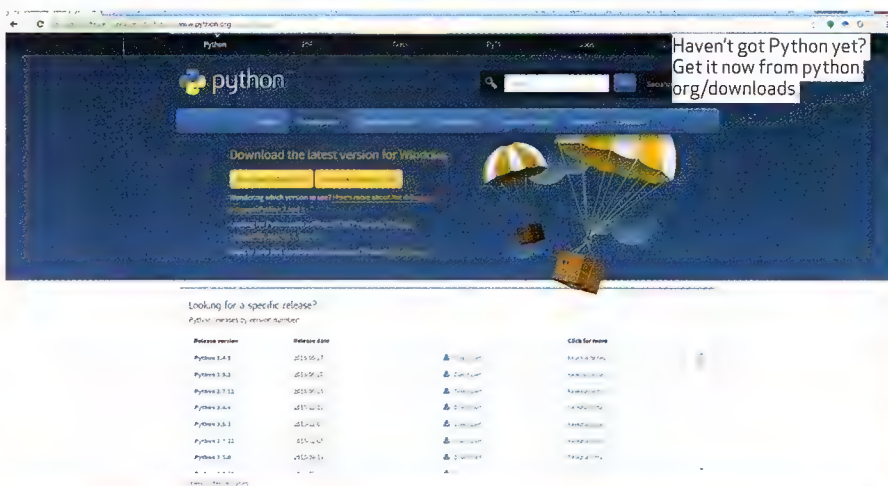
You've been asked by a client to create a simple app that allows a user to type in their before-tax salary and automatically calculates the tax payable on that salary. What do you do? The best place is to start with some pseudocode:

```

Get salary from user
Set variable 'tax' to equal 0
If salary is greater than
18200, tax equals (salary -
18200) x 0.19
If salary is greater than
37000, tax equals 3572 +
(salary - 37000) x 0.325
If salary is greater than
80000, tax equals 17547 +
(salary - 80000) x 0.37
If salary is greater than
180000, tax equals 54547 +
(salary - 180000) x 0.45
Print tax result to the user
    
```

As you can see, what we've done is just rewritten the income tax table as a series of if-statements. Let's try it out with an example: assume the user types in a salary of 250,000. Since 250,000 is greater than 18,200, we have to calculate the associated tax equation. We then get to the next statement and find that 250,000 is also greater than 37,000, so we have to calculate this one too. It's also greater

Taxable income	Tax on this income	Basic income tax tables for 2016/17 financial year in Australia.
0 – \$18,200	Nil	
\$18,201 – \$37,000	19c for each \$1 over \$18,200	
\$37,001 – \$80,000	\$3,572 plus 32.5c for each \$1 over \$37,000	
\$80,001 – \$180,000	\$17,547 plus 37c for each \$1 over \$80,000	
\$180,001 and over	\$54,547 plus 45c for each \$1 over \$180,000	



than 80,000, which means doing the equation here as well.

However, these tax equations are designed so that you only need to calculate the one your salary is closest to, but still greater than. The problem in this example is that we're actually wasting processing time by calculating tax equations for lower tax thresholds we don't need.

If your salary is 250,000, you don't need to calculate the tax at \$18,200, \$37,000 or \$80,000 because the value of tax from these equations is already

there in the value of \$54,547 in the \$180,000 tax equation.

IF-ELSE STATEMENTS

One simple solution is to reverse the if-statement order, but to also change the if-statements to if-else statements:

```

Get salary from user
Set variable 'tax' to equal 0
If salary is greater than
180000, tax equals 54547 +
(salary - 180000) x 0.45
Else If salary is greater
    
```


score.py - C:/Users/Darren/Python Code/Python_EP_2/score.py

This simple code prints different messages based on score value.

File Edit Format Run Options Window Help

```

score = int(input("Enter your test score out of 100: "))
if (score >= 50):
    print("Awesome! You passed!")
else:
    print("Bad luck - you failed.")

```

Ln: 6

tax.py - C:\Users\Darren\Python Code\Python_EP_2\tax.py (3.4)

This code will calculate income tax payable on yearly pre-tax salary.

File Edit Format Run Options Window Help

```

salary = int(input("Please enter your salary in dollars:"))
tax = 0
if (salary > 180000):
    tax = 54547 + (salary - 180000) * 0.45
elif (salary > 80000):
    tax = 17547 + (salary - 80000) * 0.37
elif (salary > 37000):
    tax = 3572 + (salary - 37000) * 0.325
elif (salary > 18200):
    tax = (salary - 18200) * 0.19
print("Tax on salary of", salary, "is", tax)

```

Ln: 1

than \$80,000, tax equals 17547 + (salary - 80000) x 0.37
 Else If salary is greater than \$37,000, tax equals 3572 + (salary - 37000) x 0.325
 Else If salary is greater than \$18,200, tax equals (salary - 18200) x 0.19
 Print tax result to the user

Here's how it works. We start by checking if the salary is greater than \$180,000. If it is, we calculate the tax. If not, we check to see if it's greater than \$80,000. Again, if not, we check to see if it's greater than \$37,000 and so on. However, when we find that the salary is greater than one of the alternative thresholds, we calculate the tax – but we only calculate the tax once.

To put it more simply, the 'if' part of the statement says what we want done when the expression is true; the 'else' part says what we want when the expression is false.

So to turn this now into actual Python code, we get:

```

salary = int(input("Please
enter your salary in dollars:
"))
tax = 0
if (salary > 180000):
    tax = 54547 + (salary -
180000) * 0.45
elif (salary > 80000):
    tax = 17547 + (salary -
80000) * 0.37
elif (salary > 37000):
    tax = 3572 + (salary -
37000) * 0.325
elif (salary > 18200):
    tax = (salary - 18200) *
0.19
print("Tax on salary of",
salary, "is", tax)

```

The 'else if' in our pseudocode becomes 'elif' in Python, but otherwise, it's not too dissimilar. You'll find this in the source code pack as 'tax.py'. Try it out.

GET PYTHON NOW!

If you missed last month's issue, it's not too late to join in – get cracking by downloading the latest version 3.5.x

Relational Operators

This... means this...

>	greater than
<	less than
==	is equal to
>=	greater than or equal to
<=	less than or equal to
!=	is not equal to

The six relational operators used for coding if-statements.

of Python from www.python.org/downloads. Once installed, launch the IDLE (integrated development and learning environment) app and you'll get the interactive Shell appear. Grab the source code from apcmag.com/magstuff, unzip it and use the IDLE menu to load in the Python files, one at a time, pressing the F5 key to execute.

See you next time! ■

downtime

» GAMES: EDITED BY TROY COLEMAN

Prague feels much more
Deus Ex at night

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Deus Ex: Mankind Divided

Takes you to a dark, beautiful world of cyborgs, conspiracies and social turmoil.

While moody protagonist Adam Jensen is fitted with military-grade mechanical implants that let him turn invisible, punch through walls, and hack computers, most of his peers in this high-tech future just have advanced prosthetics. Cybernetic replacements for a missing limb or eye. But the ordinary citizens don't see the distinction. To them, every augmented person is equally dangerous.

It's a paranoia born of the so-called Aug Event, in which augmented people around the world were driven violently insane, killing millions. Set just two years after *Human Revolution*, *Mankind Divided* is a direct continuation of this story. Augmented people are now second-class citizens, harassed by the police, viewed with suspicion wherever they go, and sent to live in slums. The city of Prague is at the heart of this anti-aug upswell, which just so happens to be Jensen's new home and where his latest employer, counter-terrorist agency Task Force 29, is based.

Prague is the only major city hub in *Mankind Divided*, which is perhaps a little disappointing. However, by focusing on a single location the artists have managed to pack in an incredible amount of detail. As you walk the streets your eyes are bombarded by holographic billboards, buzzing police drones, strange sculptures, and fascinating future-tech. It's an impressively dense, hand-crafted space, making *Human Revolution*'s cities feel pretty lifeless and cardboard in comparison.

Thankfully, the character models have been vastly improved. The dead-eyed mannequins of the last game are a distant memory, but there's still a marked difference between the high-poly main characters and the doughy NPCs.

The police presence in Prague is never a real obstacle, but there are certain situations where they'll bother you. For example, entering a metro station through the naturals-only entrance, or getting on the wrong train carriage. A scene will play where they demand to see your papers, but that's it. Although they will react to

any crimes you commit. I had a strange moment where I tasered a guy robbing a store at gunpoint, thinking I was doing a good deed, and a cop saw me. Seconds later the entire police force was hunting me down and trying to kill me.

SLUMMING IT

Jensen briefly visits Golem City, a ghetto built on the outskirts of the Czech capital to house augmented people. It's one of my favourite locations in the *Deus Ex* series so far, inspired by Hong Kong's infamous Kowloon Walled City, but it's not a proper hub.

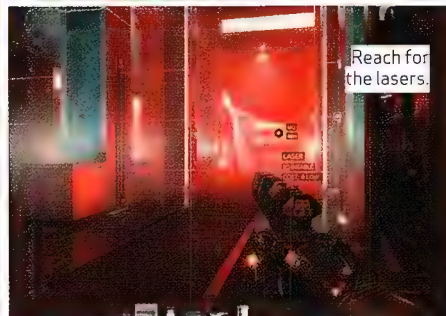
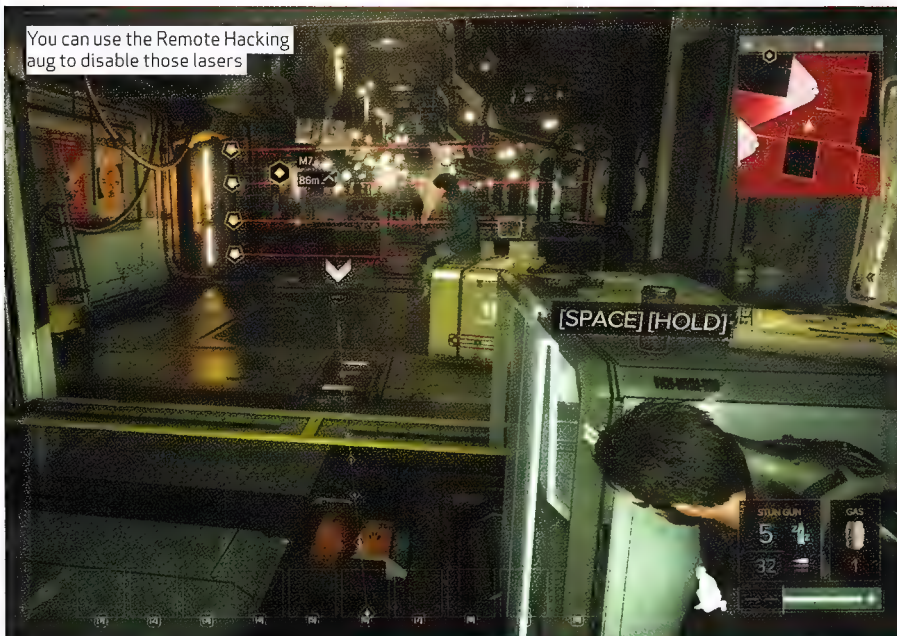
I love Task Force 29's HQ as well, which is *Mankind Divided*'s equivalent of UNATCO or Sarif Industries. I spent a good hour in here sneaking through vents into people's offices, reading their emails, stealing credit chips off their desks and talking to my colleagues.

In Prague, Jensen is caught up in a terrorist bombing at a train station and his augmentations are damaged. Before the Aug Event he could have strolled into a LIMB clinic for repairs, but there aren't any in Prague for obvious reasons. You can

see the remains of one in the city, but it's boarded up and covered in anti-aug graffiti. So he has to visit a new ally called Václav Koller, an eccentric underground augmentation expert, to get himself fixed.

It's during your repairs that a range of experimental new augs are found lying dormant in Jensen's body. Koller activates them, which is a neat way of giving you a bunch of new toys to play with. He also performs a convenient factory reset, giving you a generous pool of Praxis points to spend on reconfiguring your augmentations from scratch. There are seven new augmentations to play with. Players who like to solve problems by shooting them can use Focus Enhancement to briefly slow time, or Titan to cover themselves in thick armour for a few seconds. But I don't play *Deus Ex* that way, and you probably don't either. For stealth fans, the new Remote Hacking tool is a must-have. Point the crosshair at a camera, tripwire, mine, turret, or drone, and a simple timing-based minigame pops up. Complete it and the thing you're aiming at will stop working for a while.

The Icarus Dash is a *Deus Ex*-style take on *Dishonored*'s Blink, letting you essentially



teleport by charging it up and pointing at something – like a distant ledge or an out of reach window. It's not as responsive or satisfying to use as Blink, because finding the sweet spot to make it work can be tricky, but it gives Jensen a lot more mobility and freedom.

I'll let you discover the rest for yourself. The important thing is that there are now a lot more tools to complement your play style, which makes Jensen an even more effective Swiss Army knife.

While on a counter-terrorism mission in Dubai, which serves as the game's tutorial level, Jensen and his squad are ambushed by augmented mercenaries wearing creepy gold masks. This sets the main story in motion, and he soon finds himself tangled up in a sinister conspiracy involving the Illuminati. Honestly, it's the weakest part of the game. I never felt that invested in what was going on, and by the end I didn't feel like I'd learned anything about Jensen as a character.

The writing is inconsistent throughout, with some fun characters, and a lot of forgettable ones – including an antagonist who says, "We're not so different you and I," completely unironically. The use of real-world history to give context to the segregation and prejudice in this world is also heavy-handed – from

"Experimenting with cool augmentations and manipulating the AI and systems is exactly what I want from a Deus Ex game, and Mankind Divided frequently delivers."

"Augmented Lives Matter" slogans on posters to drinking fountains marked "aug" and "naturals". I get that science fiction, particularly cyberpunk, should hold a mirror up to our own society to reveal something about it. But *Mankind Divided* doesn't have anything interesting to say, and its political and social commentary is about as entry-level as it gets. But what the game lacks in narrative depth it makes up for with some genuinely brilliant level design. The game is at its best when it presents you with a big, interesting space full of obstacles, enemies, and things to discover and sets you loose. One mission in particular sees you breaking into a high-security bank, and it's some of the most fun I've ever had in an immersive sim. Everywhere you look there are sentry turrets, security bots, criss-crossed laser tripwires, and patrolling guards. Getting inside, stealing the particular item you're looking for, and escaping unseen was hugely satisfying.

Experimenting with cool augmentations and manipulating the AI and systems is exactly what I want from a *Deus Ex* game, and *Mankind Divided* frequently delivers. The sheer variety of ways to tackle an objective is impressive, and almost everything is designed with your augs in mind.

SIDE ORDER

Some of the game's most dramatic missions are, naturally, found in the main story. But the optional side missions are great too, and in many instances much more interesting. You can skip them, but the bonus XP they yield – which unlocks additional aug-boosting Praxis points – is invaluable. And some of them are essential to learning more about the main story, including one that explains how Jensen ended up with all those experimental augs hidden in his body, and others that give valuable context to a few key events.

One of the most memorable side missions sees you sneaking into an apartment complex filled

with tattooed gangsters, knocking one of them unconscious, then dragging his body back out unseen. It's a brilliant test of your stealth skills, and delightfully absurd.

It took me just under 30 hours to finish *Mankind Divided*, and that included taking the time to do every side mission I could find. I'm sure I missed a few. A decent length, but the final act felt rushed, and the story ended somewhat abruptly. I was left thinking "Is that it?" when the credits rolled, which is never good. Mostly, though, I just wanted more. Another city hub, another bank to rob, more missions to perform. But I guess I'll have to wait for the next game. I would also like to have seen more explicit connections to the original *Deus Ex*, but this still feels very much like a distant prequel. ■ Andy Kelly

Verdict

A beautiful, smartly-designed game set in a gorgeous futuristic city, but the story that doesn't quite do it justice.





Lovely Planet Arcade

Strips FPS design to the minimum and makes a puzzle game of it.

I have never been so angry at a pile of shapes. The greenman is two spheres on top of one another wearing a red triangle hat. He fires a red sphere my way. I waddle-juke left. He fires another. Waddle-juke right. Red blobs block my way, so I reach terminal waddle and heave myself over them with the grace of a kicked pig. I feel like I should be out of breath, but with an exasperated cough from my shotgun, I send him on his way.

That was my 15th attempt, because before I could get to this particular greenman, I had to collect some coins, shoot bombs out of the air, and jump-shoot over the shields of a few greenies. One bad swing of my mouse, one poorly timed misfire, meant death or that I wouldn't make it to the bombs before they hit the ground. Nothing waits for you in *Lovely Planet Arcade*, a time attack FPS that

ditches Y-axis aim to focus on puzzling and speed. Failure is inherent and frustrating, so shore up some patience, because *Lovely Planet Arcade* just wants to teach you sick tricks.

The basic goal in *Arcade* is to eliminate all the greenmen in a level as quickly as possible. Up to three stars are awarded for fast runs, which require near perfect execution. You can jump (barely), shooting is hitscan, and movement is slow. The thrill of acceleration is sacrificed for the thrill of executing prescriptive shooting challenges. Mistakes can't be corrected, and shooter virtuoso is determined by adherence to a specific line of tricks rather than reactive creativity. Discovering and using those shooter-tricks is the challenge here.

They start off simple enough: shoot the greenmen before they shoot you, and

do it fast. Later stages add a few wrinkles: shoot the greenmen, fast, but every other one has a shield you need to jump to hit. And later on, chaos: shoot the greenmen, jump for shields, and do it while flying across the map. Shoot a greenman with a spiral on their belly and time freezes for a second before they pull you in like a magnet. Tricks continue to layer: jump before you pop a spiral man so when you fly over you'll still be elevated, and while flying, turn 90-degrees to the right and get ready to fire. There's a shielded greenman waiting, so if you're not elevated and a second late on the trigger, he'll shoot first.

Every level uses the same tricks, but in new ways. It can be a matter of poking at every corner with every tool in the bag until inspiration hits, but once you figure out what you're supposed to do, the challenge becomes

execution. Each level has a rhythm, and a single mistake means starting again, but after innumerable attempts, nailing a particularly difficult sequence makes you feel like the most talented person alive – until the next level, and so on.

Lovely Planet Arcade boils down early shooters like *Doom* to a candy-coated fun-sized version, problems and elations included, but in richer doses. It lacks the acceleration and vertical thrills of other shooters, and I'm not dying to go back and beat my times, but *Arcade* is clean and creative FPS design in a pure, playful package. ■ James Davenport

Verdict

A fast, challenging deconstruction of old FPS design that makes up for its frustrations with heaps of charm.





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Necropolis

At its best if you dig up a few old friends.

Necropolis starts under a thick fog: you're thrown into a deep supernatural dungeon, armed with a crappy sword, a crappy shield, no instructions beyond the controls, and little hope of surviving. So you die and you try again, and you learn something and try again and again and you cheese your way through the last couple floors – and now you're like a god. And maybe a little bored, too.

Each level of the titular necropolis is procedurally generated. The first couple of floors are simple mazes of samey grey rooms, but as you descend on floating elevators, you'll start finding open air bits and swamps full of horrible marauders and monsters, all gruesomely creative. Clearing each level requires finding the next elevator room by surviving the many creatures in the way. If you die, it's back to the first floor to start all over.

Necropolis's combat is a little more *Zelda* than *Dark Souls*. Careful timing and stamina management are in play, but against most individual enemies – your skeletons, your mad acolytes,

your toad monsters – you can whack away pretty carelessly and survive. It's when you're reeling in a kite of eight or more slobbering beasts that it's scary. Several times I've been set upon by giant hordes, backed into a corner, camera peering straight down into a mess of limbs (the camera sucks in tight spaces, as cameras do), praying I can charge a special attack without being knocked out of the animation. It can be thrilling.

But after 14 hours of practice, I'm now either making easy work of the hordes on the first five-or-so levels, or being mobbed by the more vicious beasts of level six and beyond. It's either a cakewalk or it's harrowing.

Deciphering *Necropolis* (it can be frustratingly obscure) gets a lot more fun in online co-op. Up to three other players can join your run and I had a good time sharing knowledge and potions, and searching for chests and secret passages. Co-op also mitigates *Necropolis*'s cruelty, because as long as one player remains alive they can revive the others.

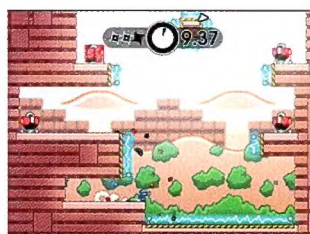
But once it all clicks there's not much to come back for. I

beat *Necropolis* by exploiting the AI and just being cautious. Because *Necropolis* likes to spawn enemies behind you in rooms you've cleared (such BS), you've got to be very careful about how many you pull from in front. So I used careful kiting and exploited the enemies' tendency to get stuck on things. I also found a crossbow, and shooting enemies from a distance doesn't activate them – they just stand still and take it. That's how I survived the final fight alone.

There were plenty of exciting moments though, especially before I really knew what I was doing. I love transforming fear into confidence and mastering the obscure – how the formerly scary skeletons are now puny to me. If you play *Necropolis*, play it before it's been too well documented, and with friends who want to figure it out with you ■ Tyler Wilde

Verdict

Ghoulish creature design and fun combat are marred by long boring stretches, and snickering obscurity.



10 Second Ninja X

Speedrunning: now in fun-size form.

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WWW.10SECOND.NINJA

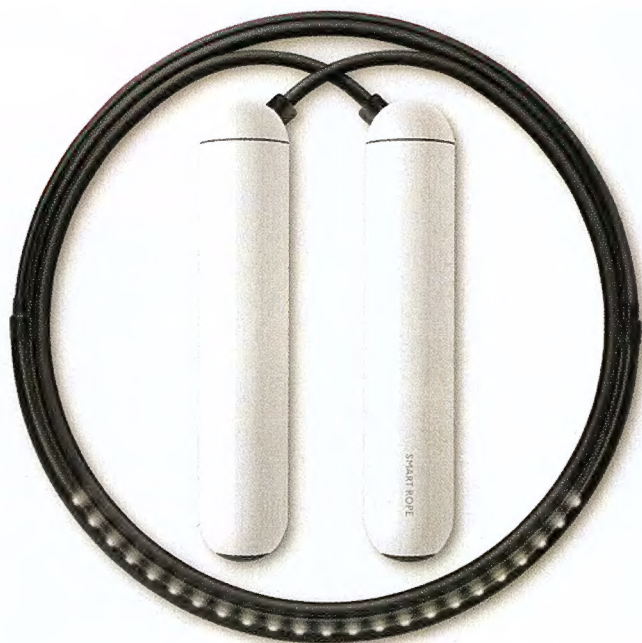
How many games can you honestly claim made you punch the air in triumph? *10 Second Ninja X* does just that. It may also, however, inspire you to punch your wall, couch or nearest solid entity with unbridled fury. Such is the nature of a game that gives you a load of tiny levels and asks you to beat them in just 10 seconds by defeating all the enemies.

This isn't actually the difficult part, though. Most of its 100 stages can be sailed through fairly comfortably within its denary countdown.

Where *10 Second Ninja X*'s challenge really lies is in trying to earn three stars on every level by finishing them even quicker. Suddenly you're no longer just playing an action platformer: you're now in a puzzle game where figuring out the quickest route through all the bad guys is just as essential as actually beating the stage.

Gamers who hold speedrunning and time trial challenges close to their hearts will be in heaven here, since the morsel-sized levels and quick restart function take the 'one-more-go' element from *N++* and shrink it down to its purest level. Just make sure you have the patience to play a level scores of times in a row to perfect your run. And be very careful what solid entity you end up punching.

■ Chris Scullion



The Tangram smart rope

Track your skips with this thing you shouldn't get.

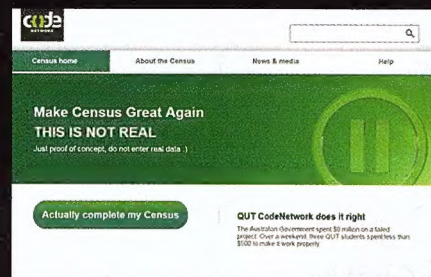
Many 'smart' devices help us in our daily lives — watches give us updates, step trackers motivate us to do more exercise, lights can provide security when we're not at home, locks can alert us when someone's trying to break them open, and so on. But this Smart Rope is a bit silly, let's be honest. Yes, its embedded LEDs show your jump count as you're skipping by creating a mid-air display, which is a cool gimmick, but that's all it is, really — a very sleek-looking gimmick. Despite its stats and leaderboards, we doubt many people will be rushing out to buy one, especially when it costs \$130 from your local Apple Store. A count-it-yourself rope costs \$4 from Kmart... just sayin'.



Does an Uber make the perfect 21st-century getaway car?

NO. NO, IT DOESN'T...

Uber is a handy way to get a ride from one place to another and, in the case of Luis Mallett, that meant getting away from Santander Bank in Weymouth, Massachusetts, after he had just robbed it. Making off with US\$700 after passing a note across to the teller that he had a bomb, Mallett grabbed an Uber but was later stopped by police and arrested. Unfortunately for him, using an Uber vehicle as a getaway car is a fundamentally flawed idea for several reasons, the least of which is that, in order to hire one, you have to give them your personal details.



Students create Census website alternative

ALL IN A FRACTION OF THE TIME,
AT A FRACTION OF THE COST.

Students from the Queensland University of Technology have proven that it's not how much money you throw at a project but the ideas that matter. These first-year students participated in a hack-a-thon and spent just 54 hours and less than \$500 creating the 'Make Census Great Again' project — a Census website alternative hosted on Amazon servers, which means that it (unlike the ABS site) could not get overloaded. According to the students, the 'serverless architecture' technology is only two years old and is designed to cope with four million page loads per hour, four times the amount of the official Census website.

Tables turned on tech support scammers

BADDIES INFECTED BACK BY
MALWARE ANALYST.

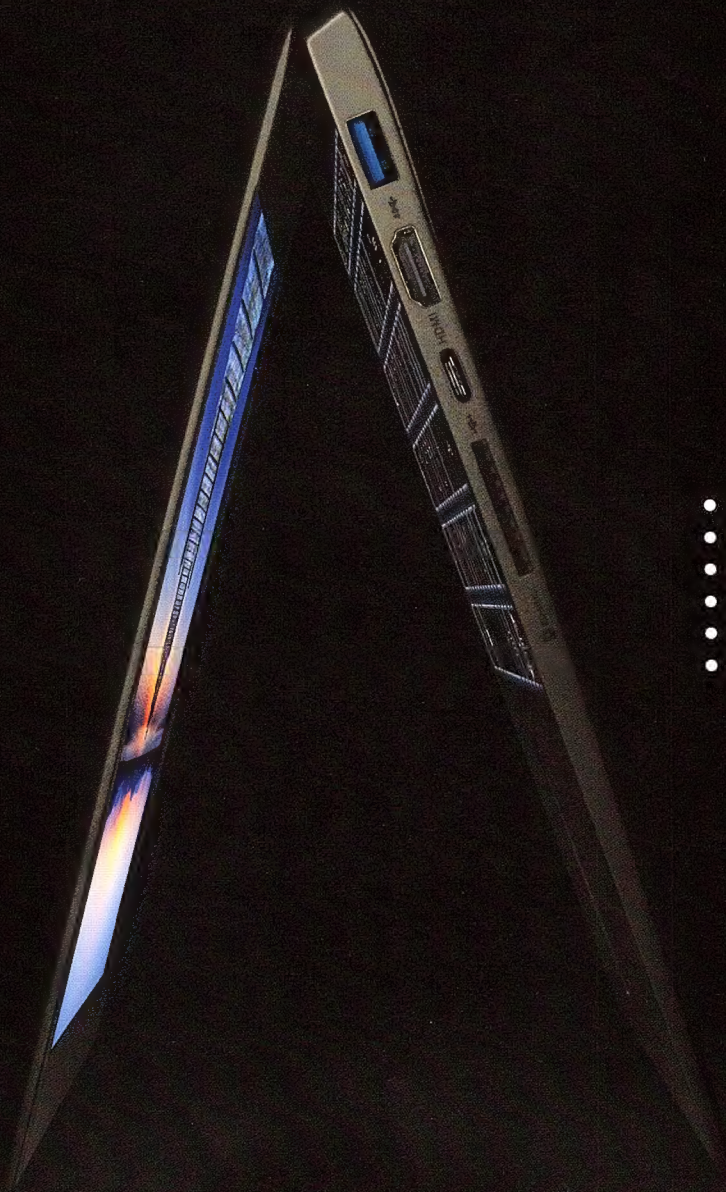
While the term 'hacker' usually carries with it a great deal of stigma due to black-hat activity, a white-hat hacker will occasionally jump in to take a swipe at online criminals in return. In this instance, a malware analyst in France, Ivan Kwiatkowski, hit back at an Indian tech support scammer who had his eyes set on the analyst's parents' PC. During a follow-up call by the scammer, Kwiatkowski sent through what he claimed was a picture of his credit card, but was actually a file containing Locky — the world's worst email-borne ransomware virus. We can only hope that the scammer's system, and any connected to it, is now so clogged with encrypted files that he needs a malware analyst to help him out! ■





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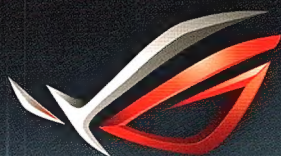
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